EARTHQUAKE AND FIRE ACT AUTHORIZATION

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

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SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

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EARTHQUAKE HAZARDS REDUCTION ACT AUTHORIZATION

TUESDAY, MARCH 15, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Washington, D.C.

The subcommittee met, pursuant to notice, at 2:06 p.m., in room 2325, Rayburn House Office Building, Hon. Doug Walgren (chairman of the subcommittee) presiding.

Present: Representatives Walgren, Brown, Dymally, MacKay, Gregg, Skeen, Boehlert, Sensenbrenner, McGrath, and Bateman.

Staff present: Carrye Brown, research assistant; and Maryanne C. Bach, technical consultant, minority.

Mr. Walgren. The hearing will come to order.

As you know, this is an authorization hearing to review the national earthquake hazards reduction program to see if the program is working at the local, State, and Federal levels.

The Earthquake Hazards Reduction Act which established the national earthquake hazards reduction program was passed in 1977 because Congress recognized that earthquake hazard mitigation is a wise national investment.

Although earthquake hazards are popularly associated with California, in fact, all or major portions of 39 States are at risk. Within these boundaries live 70 million people. The risks to life and property are as great now as when the bill was passed, and the need for a coordinated national approach is certainly no less.

The very infrequency of catastrophic events such as earthquakes tends to produce an attitude of neglect. It is the responsibility of Congress to insure that neglect of this particular act does not occur. Investment in measures to warn of and reduce the effects of earthquakes can bring great savings in lives, in recovery, and in costs of repair later on.

Implementation of this act is very complex since it involves coordination between four Federal agencies and State and local governments. Each of these has a specific responsibility and specific duties, and the balance between them is really essential for the effective operation of the whole program.

As in last year's authorization hearings, the subcommittee is concerned about FEMA's leadership role in this program. I understand that FEMA has made some progress toward carrying out its mandates under the act, and the committee is very interested in hearing testimony to that effect.

This hearing will also review the administration's proposals for the earthquake program which reduce the U.S. Geological Survey's budget by $5 million and eliminate the seismic codes and standards activities at the Center for Building Technology at the National Bureau of Standards. The national earthquake program must be evaluated in light of these proposals.

[The statement of Congressman Walgren follows:]

OPENING STATEMENT
HON. DOUG WALGREN
EARTHQUAKE AUTHORIZATION HEARING
MARCH 15, 1983

GOOD AFTERNOON, LADIES AND GENTLEMEN. THIS IS AN AUTHORIZATION HEARING TO REVIEW THE NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM TO SEE IF THE PROGRAM IS WORKING AT THE LOCAL, STATE AND FEDERAL LEVELS.

THE EARTHQUAKE HAZARDS REDUCTION ACT WHICH ESTABLISHED THE NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM WAS PASSED IN 1977 BECAUSE CONGRESS RECOGNIZED THAT EARTHQUAKE HAZARD MITIGATION IS A WISE NATIONAL INVESTMENT.

ALTHOUGH EARTHQUAKE HAZARDS ARE POPULARLY ASSOCIATED WITH CALIFORNIA, IN FACT, ALL OR PORTIONS OF 39 STATES ARE AT RISK. WITHIN THESE BOUNDARIES LIVE 70 MILLION PEOPLE. THE RISKS TO LIFE AND PROPEPRTY ARE AS GREAT NOW AS WHEN THE BILL WAS PASSED, AND THE NEED FOR A COORDINATED NATIONAL APPROACH IS EQUALLY GREAT.

THE VERY INFREQUENCY OF CATASTROPHIC EVENTS SUCH AS EARTHQUAKES TENDS TO PRODUCE AN ATTITUDE OF NEGLECT. IT IS THE RESPONSIBILITY OF CONGRESS TO INSURE THAT NEGLECT OF THIS PARTICULAR ACT DOES NOT OCCUR. INVESTMENT IN MEASURES TO WARN OF AND REDUCE THE EFFECTS OF

EARTHQUAKES CAN BRING GREAT SAVINGS IN LIVES, IN RECOVERY, AND IN COSTS OF REPAIR LATER ON.

IMPLEMENTATION OF THIS ACT IS VERY COMPLEX SINCE IT INVOLVES COORDINATION BETWEEN FOUR FEDERAL AGENCIES AS WELL AS STATE AND LOCAL GOVERNMENTS. EACH OF THESE HAS A SPECIFIC RESPONSIBILITY AND SPECIFIC DUTIES, AND MAINTAINING THE BALANCE BETWEEN THEM IS ESSENTIAL FOR THE EFFECTIVE OPERATION OF THE PROGRAM.

AS IN LAST YEAR'S AUTHORIZATION HEARINGS, THE SUBCOMMITTEE IS CONCERNED ABOUT FEMA'S LEADERSHIP ROLE IN THE PROGRAM. I UNDERSTAND THAT FEMA HAS MADE PROGRESS TOWARDS CARRYING OUT ITS MANDATED RESPONSIBILITIES, AND I LOOK FORWARD TO HEARING THE TESTIMONY OF LOWELL DODGE OF THE GENERAL ACCOUNTING OFFICE ON THIS MATTER.

THIS HEARING WILL ALSO REVIEW THE ADMINISTRATION'S PROPOSALS FOR THE EARTHQUAKE PROGRAM WHICH REDUCE THE U.S. GEOLOGICAL SURVEY'S BUDGET BY $5 MILLION AND ELIMINATE THE SEISMIC CODES AND STANDARDS ACTIVITIES AT THE CENTER FOR BUILDING TECHNOLOGY AT THE NATIONAL BUREAU OF STANDARDS. THE NATIONAL EARTHQUAKE PROGRAM MUST BE EVALUATED IN LIGHT OF THESE PROPOSALS.

I LOOK FORWARD TO HEARING THE TESTIMONY OF THE WITNESSES.

Mr. **Walgren**. The committee did make a site visit to the National Bureau of Standards and toured the seismic codes and standards program that they have running there. Therefore, we will be very interested, to say the least, in the arguments that are made about that particular program.

With that, let me ask the first panel to proceed.

We have Richard Krimm, the Assistant Associate Director of the Office of Natural and Technology Hazards, Federal Emergency Management Agency.

We also have Dallas Peck, Director, U.S. Geological Survey, who is accompanied by Darrell Herd, Deputy Director, Plans and Programs, Office of Earthquakes, Volcanoes, and Engineering.

We also have Jack T. Sanderson, the Assistant Director of Engineering for the National Science Foundation, and Richard Wright, the Director for the Center for Building Technology of the National Bureau of Standards.

With that, let me invite you to proceed. Your written statements will be made part of the record and will serve as a reference point for the subcommittee to use in discussion. Please summarize or proceed as best you feel comfortable in communicating the major points to the subcommittee.

With that, why don't we start with Director Krimm?

[The biographical sketch of Mr. Krimm follows:]

RESUME

RICHARD W. KRIMM

A native of Williamsport, Pennsylvania, Mr. Krimm is a graduate of Dartmouth College, Hanover, New Hampshire, with a degree in English and History. He attended the New York University Graduate School of Business Administration, majoring in Management. From 1956 to 1957 he served in the United States Army, Counter Intelligence Corps.

After the Army, he spent six years managing a family-owned lumber manufacturing business. When the business was sold in 1964, he was appointed to the Pennsylvania Insurance Department by Governor Scranton.

From 1964 to 1970, he served in the Pennsylvania Insurance Department in several capacities from the examination, licensing and regulation of insurance agents, as Director of the Rating Bureau and as Deputy Commissioner for Companies. He worked on several committees of the National Association of Insurance Commissioners.

In March of 1970, he joined the Federal Insurance Administration as Assistant Administrator for Flood Insurance.

During the development period of the National Flood Insurance Program, Mr. Krimm worked closely with the National Association of Flood Insurers, a partnership of the Federal Government, and the insurance industry, to expand the program. After the disasterous floods in 1972 and 1973, the program was strengthened by the Flood Disaster Protection Act of 1972. Mr. Krimm assisted in the drafting of this legislation and worked diligently for the passage of the Act.

When the Federal Insurance Administration became part of the Federal Emergency Management Agency in 1978, Mr. Krimm was appointed Assistant Administrator for the Office of Natural Hazards Reduction. In this capacity, he was responsible for the expansion of the flood plain management portion of the program including the initiation of a State Assistance Program and a Property Acquisition Program.

From January to June 1981, he served in the capacity of Acting Federal Insurance Administrator, in change of the National Flood Insurance Program, the Crime Insurance Program, and the Riot Reinsurance Program.

Currently, he is Assistant Associate Director for the Office of Natural and Technological Hazards, which include preparedness plans for natural hazards such as earthquakes, hurricanes, floods, mudslides, erosion and dam safety and technical hazards such as radiological emergency planning and hazardous materials.

STATEMENT OF RICHARD KRIMM, ASSISTANT ASSOCIATE DIRECTOR, OFFICE OF NATURAL AND TECHNOLOGY SERVICES, FEDERAL EMERGENCY MANAGEMENT AGENCY

Mr. KRIMM. Thank you very much. Mr. Chairman, it is a pleasure for me to appear on behalf of Louis O. Giuffrida, Director of the Federal Emergency Management Agency, to present FEMA's comments on the national earthquake hazard reduction program in connection with the reauthorization of the Earthquake Hazards Reduction Act of 1977.

I am presenting highlights of my statement, which I am requesting, Mr. Chairman, be made part of the record of this hearing.

Mr. WALGREN. It will be done immediately following your oral presentation.

Mr. KRIMM. FEMA has assumed an active leadership role in the earthquake program. An Earthquake Policy Group, consisting of the senior officials charged with administering the respective agencies' earthquake programs, has been formed to direct the overall activities of the Interagency Coordinating Committee.

To insure that there is only one coordinating committee, responsibilities for developing the Federal response plan for the catastrophic earthquake, and the activities of the Interagency Committee for Seismic Safety in Construction are now carried out under subcommittees of the Interagency Coordinating Committee.

FEMA has established an independent panel, headed by Dr. Karl Steinbrugge, to review the national earthquake hazards reduction program 5-year plan. Mr. Steinbrugge has formed a group of 25 experts representing all related earthquake disciplines to conduct the review. It is my understanding that the review of the 5-year plan will be completed and submitted to FEMA for endorsement to Congress in the near future.

The plan, which represents a synthesis of materials provided by other agencies involved in earthquake related activities, is challenging but realistic, and FEMA is prepared to endorse the plan and act as an advocate for its implementation for the executive branch, provided, of course, that there are no potential conflicts in substantive areas with the President's total administrative program. FEMA also will insure that the national earthquake hazards reduction program follows the plan.

As chairman of the Subcommittee on Federal Earthquake Response Planning, FEMA has initiated an extensive planning effort involving at least 22 Federal departments and agencies. The subcommittee has developed a planning guide that can be used as an interim operative plan for response and as the framework for developing a comprehensive national Federal plan.

During the past year FEMA has continued to pursue a two-pronged activity to foster the development of improved seismic safety building provisions in both the private and the public sectors. For the private sector, the Building Seismic Safety Council is conducting trial designs of the tentative provisions developed by the Applied Technology Council. This activity will result in issuance of a source document for use by building code organizations as well as State and local building officials. A program to encourage its adoption by the private sector is planned.

In a parallel effort, FEMA has continued to encourage Federal agencies to adopt similar and, if necessary, more stringent seismic provisions in their construction and grant leasing activities.

The Interagency Committee on Seismic Safety for Construction has been restructured and given new policy level membership. Under this new leadership, increased high-level management attention and greater resources, the Interagency Committee on Seismic Safety and Construction will show results during the next year.

Thank you. This concludes my testimony. I will be very glad to answer any questions.

[The prepared statement of Richard W. Krimm follows:]

TESTIMONY BY

RICHARD W. KRIMM

ASSISTANT ASSOCIATE DIRECTOR
of

OFFICE OF NATURAL AND TECHNOLOGICAL HAZARDS

STATE AND LOCAL PROGRAMS AND SUPPORT

SUBMITTED TO THE

HOUSE SUBCOMMITTEE ON SCIENCE, RESEARCH, AND TECHNOLOGY

COMMITTEE ON SCIENCE AND TECHNOLOGY

March 15, 1983

It is my pleasure to appear before this subcommittee on behalf of Louis O. Giuffrida, Director of the Federal Emergency Management Agency (FEMA), to present FEMA's comments on the National Earthquake Hazard Reduction Program (NEHRP) in connection with the reauthorization of the Earthquake Hazards Reduction Act of 1977.

The Earthquake Hazards Reduction Act of 1977 (PL 95-124), as amended, identifies some of the objectives of the NEHRP as being:

1. development of technologically and economically feasible design and construction methods and procedures to make new and existing structures, in the areas of seismic risk, earthquake resistant, giving priority to the development of such methods and procedures for nuclear power generating plants, dams, hospitals, schools, public utilities, public safety structures, high-occupancy buildings, and other structures which are especially needed in time of disaster;

2. implementation in all areas of high or moderate seismic risk of a system (including personnel, technology, and procedures) for predicting damaging earthquakes and for identifying, evaluating, and accurately characterizing seismic hazards;

3. development, publication, and promotion, in conjunction with State and local officials and professional organizations, of model codes and other means to coordinate information about seismic risk with land-use policy decisions and building activity;

4. development, in areas of seismic risk, of improved understanding of, and capability with respect to, earthquake-related issues, including methods of controlling the risks from earthquakes, planning to prevent such risks, disseminating warnings of earthquakes, organizing emergency services, and planning for reconstruction and redevelopment after an earthquake.

5. education of the public, including State and local officials, as to earthquake phenomena, the identification of locations and structures which are especially susceptible to earthquake damage, ways to reduce the adverse consequences of an earthquake, and related matters;

6. development of research on

    a. ways to increase the use of existing scientific and engineering knowledge to mitigate earthquake hazards;

    b. the social, economic, legal, and political consequences of earthquake prediction;

    c. ways to assure the availability of earthquake insurance or some functional substitute; and

7. development of basic and applied research leading to a better understanding of the control or alteration of seismic phenomena.

These stated objectives can be grouped into four general categories of activities: basic research, mitigation, preparedness/response, and public education/information dissemination. All NEHRP activities fall into one of these categories in achieving the program objectives.

FEMA assumed the leadership and coordination of the NEHRP when the program was transferred to FEMA with the establishment of the Agency in 1979 under the Presidential Reorganization Plan No. 3 of 1978. The United States Geological Survey (USGS), the National Science Foundation (NSF), and the National Bureau of Standards (NBS) are the other principal agencies involved in the NEHRP and represent the largest portion of the program activities and budget allocations. In addition, numerous other Federal agencies participate in various phases of the activities of the program.

Last year, some concerns were expressed by Congress regarding FEMA's leadership role, NEHRP management and direction, and some specific program activities, and some requests were made toward improving the Program. Specifically:

- Concern was expressed as to whether FEMA could effectively be the lead agency when other agencies have programs so much larger (budgets eight to ten times as large) and whether FEMA is devoting adequate resources and priority to meeting its responsibilities.

- It was requested that the NEHRP or the Administration conduct an intensive review, preferably under independent leadership, to determine the best way to manage, structure, and staff the NEHRP to achieve the objectives stated in the Act and ensure adequate program management and direction.

- It was requested that the NEHRP develop a detailed program plan—with increased cohesion among the four principal agencies, including conduct of joint projects and development of better-coordinated efforts and more-compatible budgets.

- It was requested that the NEHRP increase the utilization and implementation of research-derived knowledge and that FEMA direct its attention to mitigation as well as post-earthquake response considerations.

- Concern was expressed that the United States was still far from having an earthquake prediction capability comparable to ones that exist elsewhere in the world and suggested that international information exchange efforts be increased.

In addressing these concerns and requests, I would first like to assure this Committee that FEMA takes its responsibilities as the lead and coordinating agency for the NEHRP seriously and will devote whatever resources are required to ensure that the program receives the priority and attention needed to meet its objectives within FEMA and throughout the Federal Government. FEMA's activities in this regard will be discussed in addressing the specific management concerns expressed.

The fact that FEMA has the smallest portion of the program activities is, we believe, an advantage rather than a disadvantage in providing the necessary leadership and management direction. FEMA has a broad perspective, a strong

State and local interaction and interface network, and an integrated emergency management framework. This, along with USGS's close working relationship with the various State geologists ensures that all the objectives of the Act are met.

In response to Congressional concerns regarding the direction of the whole program, the need for a five-year program plan, and FEMA's managment and coordination roles, FEMA last spring selected Mr. Karl V. Steinbrugge, the internationally known expert, to conduct an independent review of the NEHRP and form a panel to provide consultation and advice. He was given a free hand to proceed in this task as he deemed best. He, in turn, selected a group of 25 experts representing all relevant disciplines and State/local governments to aid him in reviewing the NEHRP Five-Year Plan and a smaller group to act as advisory group. It is my understanding that the review of the Five-Year plan will be completed and submitted to FEMA for endorsement to Congress within the next 90 days. The Plan, which represents a synthesis of materials provided by other agencies involved in earthquake-related activities, is challenging but realistic, and FEMA is prepared to endorse the plan and act as an advocate for its implementation for the Executive Branch, provided, of course, that there are no potential conflicts in substantive areas with the President's total administrative program. FEMA also will ensure that the NEHRP follows the plan.

FEMA has assumed an active leadership role in the earthquake program. I would like to cite several examples of those leadership responsibilities. First, an Earthquake Policy Group consisting of Drs. Jack Sanderson, Dallas Peck, John Lyons, and Lee Thomas--the Administration officials charged with running our respective Agencies' earthquake programs--has been established. They have already met on several occasions to discuss substantive issues--the five-year earthquake plan and pending program hearings. This group directs the overall activities of the Interagency Coordinating Committee for the National Earthquake Hazards Reduction Program (ICC NEHRP) and charges them with specific tasks.

The ICC NEHRP has continued to meet and to discuss substantive issues. To ensure that there was only one coordinating committee, we have brought under the umbrella of the ICC NEHRP the responsibilities for developing the Federal response plan for the catastrophic earthquake as well as the activities of the Interagency Committee for Seismic Safety in Construction (ICSSC). Both activities are now carried out as subcommittees of the ICC NEHRP.

A third example is the development of the five-year plan, which I discussed previously. As a final example, FEMA and the USGS have executed a Memorandum of Understanding directed toward coordinating our joint efforts in specific earthquake-related areas. Already staff from our respective agencies have begun work in the following areas: operational response, prediction/warning, public information and education, and long-term mitigation. Attached to my testimony is a copy for the record.

NEHRP efforts to strengthen the mitigation, public information and education, and international exchange aspects of the program will be discussed by each agency in its program presentation.

During the past year, FEMA has continued to pursue a two-pronged activity to foster the development of improved seismic safety building provisions in both the private and public sectors.

For the private sector, FEMA funded an effort to be conducted by the Building Seismic Safety Council (BSSC). Representing all segments of the design and construction industry, the BSSC presently is conducting trial designs of the tentative provisions developed by the Applied Technology Council. For this effort, the BSSC is using the design of 27 buildings in four high- and moderate-risk areas (Los Angeles, Seattle, Memphis, and Phoenix). A second phase of this contract will include 20-25 more buildings in five to six additional cities (New York, Chicago, St. Louis, Fort Worth, Charleston, and possibly Boston). A concluding phase will evaluate the results of the trial designs, modify the provisions, as necessary, and derive regulatory and socioeconomic implications of the provisions. A source document for use of code organizations as well as State and local building officials will be issued and a long-range program of encouraging its adoption by the private sector will be started.

In a parallel effort, FEMA is pursuing a policy of encouraging Federal agencies to adopt similar and, if necessary, more-stringent seismic provisions in its construction and granting leasing activities. In this respect, it is essential that the Federal Government set a suitable example of earthquake mitigation by "getting its own house in order." The mechanism for action in the Federal sector is the Interagency Committee on Seismic Safety in Construction (ICSSC), in which 23 Federal Departments and Agencies participate. After developing and publishing a draft seismic standard for new Federal buildings in 1981, the work of the committee suffered from a somewhat lower level of attention and resources than would have been desirable. Consequently, Federal agencies have lagged behind in pursuing this area with vigor. During the past year, however, the ICSSC was assigned a new chairman, placed under the overall structure of the ICC NEHRP (as stated earlier), given new and policy-level membership, and restructured into a steering group and four subcommittees (instead of 10 subcommittees and a task group). Under this new leadership, increased high-level management attention, and greater resources, the ICSSC will show results during the next year.

FEMA's projects within the overall NEHRP consist primarily of assisting State and local governments in carrying out their responsibilities for public safety and welfare, ensuring that the States and local communities have the information and tools needed to develop their programs and educate the public, and develop a Federal response plan and ensure earthquake hazard mitigation within Federal programs.

During FY 82, FEMA's work with the States and local communities in site-specific high and moderate seismic risk areas to develop preparedness and mitigation programs has continued to develop and expand in scope. As vulnerability analyses conclude, preparedness plans are developed. These critical plans for saving lives when the event occurs are essential. Following the response planning effort, the focus shifts toward mitigation efforts and increased public awareness and education in support of those activities.

The Southern California Earthquake Preparedness Project (SCEPP) is now beginning to shift from the initial response planning to the longer-term mitigation and education activities. The processes developed under SCEPP soon will be transferred to other high and moderate seismic risk areas that are in the early phases of program development—vulnerability assessment and preparedness planning. In a manner similar to actual response and recovery operations, vulnerability assessment and preparedness planning lead to the awareness needed to initiate an effective mitigation effort for future events. By developing a mitigation program after the preparedness process is well underway, the communities' awareness of hazards, community responsibilities, and needs has been heightened.

In previous testimony, FEMA representatives have discussed the comprehensive, multihazard approach FEMA has initiated in its realignment. A good example of FEMA's comprehensive approach and how it can benefit all natural hazard reduction efforts including earthquakes is a pilot project that we are exploring with the State of Utah and other Federal agencies under our dam safety program. The Cities of Salt Lake, Provo, and Ogden are situated along the Watasch Fault. About 85 percent of the State's population lives in this area beside the mountain slopes and along the valleys. Also in this area of high seismic risk are numerous dams that could fail as a result of a severe earthquake. As preparation for an earthquake, a hospital emergency room facility with emergency generators has been established by Utah's emergency services department. However, if dams were to fail as a result of an earthquake or in the course of a flood event, the stored water would rush down the canyons and the low-level emergency facility could be flooded. Thus, a real need exists for a multihazard approach to the State's emergency services, leading to our exploration with the State of a pilot project on multihazard monitoring and a real-time warning system.

Each preparedness and mitigation project area is unique. Study areas may include a major city, such as Boston; encompass several cities and counties, such as the San Francisco Bay and Puget Sound areas; involve more than one State, such as the central U.S. and Charleston, S.C., study areas; and possibly require a cooperative planning partnership with another country, such as Upper New York State with Canada, San Diego with Mexico, and Puerto Rico with adjacent Caribbean governments. Because of the unique characteristics of these earthquake study areas, it is not practical to assume that identical coalitions can be formed in each area. It is, however, possible to replicate the basic support concept and process.

Because some at-risk areas of the country are not as familiar with earthquake processes and hazards as California, FEMA has initiated a hazard awareness and education program for these areas. We will be field testing these products in the central and southeastern United States through a prototype community outreach project. This project will establish earthquake education centers (EEC) in existing institutions in these areas. The EECs will recruit and train a cadre of volunteers to extend the EEC community outreach capability. These EECs will be models for additional centers scheduled for funding in other areas in late FY-84 and beyond. Both the USGS and NSF have agreed to participate in this prototype effort by supplying the EECs with materials and assisting in developing tracking mechanisms for continuous project evaluation.

To ensure that the Federal Government is prepared to respond to a catastrophic earthquake (in California and any high-risk, high-population area of the country), FEMA initiated an extensive planning effort that will involve at least 22 Federal Departments and Agencies. At this time, the focus of planning is on Federal augumentation of State and local government response capability with the support necessary to save and protect lives and meet basic human needs.

To coordinate this planning effort, FEMA established and chairs a Subcommittee on Federal Earthquake Response Planning under the auspices of the ICC NEHRP. During the past six months the subcommittee developed a planning guide that establishes a framework for development of a comprehensive National Federal Plan. The guide could serve also as an interim operation plan for response.

Within the next few days, a notice will be published in the Federal Register to officially initiate the planning effort and to involve the Departments and Agencies not included on the subcommittee. The notice includes a schedule for plan development and exercises, with a full exercise in April 1985 to test the ability of the Federal Government to respond to a catastrophic earthquake in California. This plan and exercise program schedule satisfies the timeframes established by the Emergency Mobilization Preparedness Board (EMPB) and the earthquake response implementation measures assigned to FEMA in the EMPB's National Plan of Action for Emergency Mobilization.

In the meantime, Regional Federal planning continues under the leadership of FEMA Region IX in California. A final plan is almost completed and ready for submission to the National level for review. Numerous other Federal agencies have been involved in this effort and previous response efforts in Salt Lake City and Puget Sound. The experience of these Regional efforts will be used as the basis for the National planning effort. An important objective of the National plan development is to establish the policies and procedures that should be applied throughout the Federal establishment while at the same time allowing flexibility to recognize constraints and opportunities that are unique to response in a particular geographic risk area.

That concludes my testimony. I would be glad to answer any questions.

MEMORANDUM OF UNDERSTANDING
BETWEEN
FEDERAL EMERGENCY MANAGEMENT AGENCY
AND
U.S. GEOLOGICAL SURVEY

I. Purpose

The Federal Emergency Management Agency (FEMA) and the U.S. Geological Survey (USGS) are committed to assisting Federal, State, and local governments in reducing the Nation's vulnerability to the effects of geologic and hydrologic hazards by upgrading mitigation, preparedness, response, and recovery efforts. FEMA and the USGS enjoy a cooperative relationship and agree to continue working together in areas of common concern and capability. This Memorandum of Understanding (MOU) provides a framework within which activities of mutual concern can be pursued. Details concerning working relationships on various projects will be appended to this document as they are developed. It is understood that there may be unusual circumstances requiring special negotiations and arrangements not specified in this document.

II. Authorities/Responsibilities

A. FEMA

FEMA was established by Reorganization Plan No. 3 of 1978 and placed into effect by Executive Orders 12127 of March 31, 1979 (44 Federal Register 19367) and 12148 of July 20, 1979 (44 Federal Register 43239) in order to create a single focus of emergency management activities of the Federal Government. FEMA's responsibilities in the areas of emergency management include, but are not limited to, mitigation, preparedness, response, and recovery functions. Among its principal functions and activities, FEMA establishes policy for and coordinates civil defense and civil emergency and disaster planning of all Executive Agencies; assists State and local governments in the coordination of mitigation, preparedness, response, and recovery activities; develops and executes programs and policies for fire prevention and control; manages the National Earthquake Hazard Reduction Program and the National Flood Insurance Program; and serves as the coordinator of all Federal Agencies and Departments responsible for emergency assistance.

B. USGS

The USGS was established by the Organic Act of March 3, 1879 (20 Stat. 394, 43 U.S.C. 3) which provided for "The classification of the public lands and the examination of the geological structure, mineral resources, and products of the National Domain." Among its broad responsibilities and efforts are identification, assessment, and monitoring of potentially hazardous areas; development of capabilities to predict the time, place, and the severity of hazardous geologic and hydrologic events; and dissemination of the findings and their implications, including the provision of technical and scientific advice to public officials. The USGS also maintains Bureau-wide efforts intended to educate the public about the nature of geologic and hydrologic hazards.

III. Areas of Coordination

As a result of negotiations between FEMA and USGS, areas of cooperation, coordination, and collaboration have been identified that will contribute to joint mitigation, preparedness, response, and recovery activities. Areas of mutual concern identified are categorized as:

A. Areas of Priority Concern: Both agencies agree that existing relationships and procedures should be formalized and supplemented through implementation of this MOU. The following areas are the most critical to insuring appropriate actions by each agency and will be addressed through priority development of annexes that specify the working arrangements between FEMA and USGS in:

1. Operational Response

Develop policies and procedures that establish working relationships to insure an effective, coordinated response to a potential or existing geologic or hydrologic hazard.

2. Prediction/Warning

Develop policies and procedures for early and coordinated dissemination of information to appropriate Federal, State, and local officials related to the potential occurrence of a geologic or hydrologic hazard.

3. Public Information and Education

Develop policies and procedures to produce, disseminate, and implement programs that provide the general public with information to use in making decisions on how to prepare for and respond to a prediction, warning, or occurrence of a geologic or hydrologic hazard.

4. Long-term Mitigation

Develop policies and procedures that support hazard assessments and mitigation techniques. Develop mechanisms for: applying and transferring information related to hazard assessments and mitigation techniques; assisting in their implementation and use; evaluating their effectiveness; and, recommending improvements and alternative techniques for implementation of mitigation measures.

B. Areas of Existing Relationships: The areas below may or may not be addressed adequately in development of the annexes identified above. As the need is identified, specific additional annexes will be developed to insure that mutual responsibilities and concerns are addressed. In the meantime, existing arrangements and relationships will continue.

1. Technical Assistance

FEMA and USGS agree to provide technical assistance to each other on a mutually agreeable basis. Guidelines and procedures for requesting and providing technical assistance will be handled on an informal, case-by-case basis.

2. Training and Education

FEMA and USGS agree, in principle, to exchange and coordinate training and education programs.

IV. Implementation

The FEMA Associate Director for State and Local Programs and Support and the USGS Assistant Director for Engineering Geology are assigned the responsibilty to discharge this agreement, identify additional areas of mutual concern, and develop appropriate annexes. Each agency will provide such support as required to implement this agreement. This MOU will become effective upon signing by both parties. It may be terminated by either party upon 90 days written notice.

This agreement formally declares the intent of both agencies to carefully consider and construct the proper FEMA and USGS individual and joint response to geologic conditions that threaten public safety and property.

Dave McLoughlin

Dave McLoughlin
Acting Associate Director
State and Local Programs
and Support
Federal Emergency Management
Agency

Date 11/3/82

Dallas L. Peck
Director
U.S. Geological Survey

Date

Mr. WALGREN. Thank you, Director Krimm.

Let's turn next to Director Peck of the Geological Survey.

[The biographical sketch of Dr. Peck follows:]

DALLAS LYNN PECK

Born: Cheney, Washington, March 28, 1929

Education: Primary schools, Cheney and Spokane, Washington, and Missoula, Montana; Lewis and Clark High School, Spokane, 1947; California Institute of Technology, B.S. in geology with honors, 1951, M.S. in geology (concentration in mining geology), 1953; Harvard University, Ph.D. in geology (concentration in mining geology, 1960.

Professional Employment: Geologic field assistant, U.S. Geological Survey, part-time, 1951-53; Geologist, U.S. Geological Survey, 1954-77; Chief Geologist, U.S. Geological Survey, September 1977-81. Director, U.S. Geological Survey, September 1981-.

Professional Experience: Geology of western Oregon, and volcanic rocks of the western Cascade Range, 1954-59. Geology of the central Sierra Nevada, California, and granitic rocks of the Sierra Nevada Batholith, 1959-63, 1972-77. Hawaiian Volcano Observatory (activity of Kilauea Volcano and cooling processes in lava lakes), 1963-66. Assistant Chief Geologist for Experimental Geology (later, Geochemistry and Geophysics), 1967-72. Adviser to the National Science Foundation (Earth Sciences Advisory Committee), 1969-72; National Research Council (Fullbright-Hays Program, Advisory Screening Committee for Earth Sciences), 1974-77; National Research Council (Advisory Board to the Office of Earth Sciences), 1975-79; Sandia Laboratories (Magma Energy Project), 1975-76; Los Alamos Scientific Laboratories (Geosciences Advisory Panel), 1975-77; the Harvard University (Visiting Committee of the Board of Overseers to the Department of Earth Sciences), 1972-77; University of California, Berkeley, Dean of Graduate Studies, 1980; and Stanford University, School of Earth Sciences, 1982-. Representative to the Third General Meeting of the US-Japan Cooperative Sciences Program (Japan), 1965; to the Symposium of the International Association of Volcanology (New Zealand), 1965; to the Surtsey Research Conference (Iceland), 1967; to the Symposium on Geothermal Power (Italy), 1970; to the International School of Earth Sciences (Erice, Italy), 1973; and to the US-Japan Scientific Cooperative Conference on Volcano Energy (Hawaii), 1974. Delegate to Moscow (USSR) as a member of the US/USSR Joint Commission on Scientific and Technical Cooperation--Energy Working Group, 1972; U.S. Delegate to the assembly in Durham (England) of the International Association of Volcanology and Chemistry of the Earth's Interior, 1977.

Scientific and Professional Societies: American Association for the Advancement of Science (Fellow); American Geophysical Union (Fellow), (Past-President, Section on Volcanology, Geochemistry, and Petrology); Geological Society of America (Fellow and Council Member); Geological Society of Washington (Past-President); Mineralogical Society of America; Peninsular Geological Society; and the Society of Economic Geologists.

Honors: Department of the Interior Meritorious Award, 1976.
Department of the Interior Distinguished Service Award, 1979.
Presidential Meritorious Executive Award, 1980.

STATEMENT OF DALLAS L. PECK, DIRECTOR, U.S. GEOLOGICAL SURVEY, ACCOMPANIED BY DARRELL HERD, DEPUTY CHIEF, PLANS AND PROGRAMS, OFFICE OF EARTHQUAKES, VOLCANOES, AND ENGINEERING

Dr. PECK. Thank you. It is a pleasure to be here before the committee today.

Ten days ago we celebrated the 104th anniversary of the founding of the Geological Survey. We serve the Nation engaged in topographic and geologic mapping, in monitoring and providing information on the quality and quantity of water resources, and on assessing geologic resources and hazards.

Our work in geologic hazards involves research, monitoring, hazards assessment, and warnings of volcanoes, earthquakes, landslides, and other ground failures. The work is not purely academic. I have the responsibility by Federal statute to issue warnings, when possible, of geologic catastrophes.

The geologic hazard we address today concerns earthquakes. Our written statement addresses four issues over which this committee has in the past expressed concern. One has to to with funding for earthquake studies. The second is the status of earthquake predictions. The third is the leadership of the national program, and the last is the utilization of the research.

In addition, we are requesting a 3-year authorization.

I shall comment on each of these issues briefly.

On the budget, the appropriated funding over the past 6 years has remained fairly constant at $30 million. The increased appropriation in fiscal year 1983 is due to a transfer of $1.2 million from the National Science Foundation for work previously done on a reimbursable basis and an additional several million added by congressional action.

The fiscal year 1984 budget request, $29.5 million, reflects the administration's policy to hold Federal discretionary funding in check and the requirements of other programs within the Survey.

The President's budget for fiscal year 1984 is decreased somewhat over 10 percent from what it was in fiscal year 1983. With the funds available, we shall attempt to keep the essential monitoring and data service activities intact. Reductions will be concentrated in theoretical and laboratory work, with some reductions in monitoring in areas of lower risk.

In the area of earthquake prediction, earthquake prediction remains a challenging problem that we have yet to solve. Devastating, major earthquakes are fairly rare. Thus, the opportunity to gain experience in predicting them does not happen very often.

We have a dense geochemical and geophysical monitoring network in California and elsewhere. These are being used to study the problem. They have been the basis for the advisories that we have issued.

Despite our continuing research and our initial efforts in earthquake warnings, we do not issue earthquake predictions and advisories on a routine basis. To do so would require a significant increase in our scientific understanding of earthquake processes, and, in addition, a major investment in equipment, data transmission lines, and computers. We cannot recommend a major investment in an operational earthquake prediction system, given the current state of our knowledge. We shall, however, continue to work to improve our scientific understanding and monitoring capabilities in an evolutionary manner.

As far as program leadership is concerned, we have worked very closely with FEMA over the past year to improve the direction and coordination of the national earthquake hazard reduction program. We have executed a memorandum of understanding, and we have met on the earthquake program with Lee Thomas three or four times over the past year. We have participated in the development of the 5-year program.

We are confident that these steps and the sense of cooperation that has developed between our agencies will allow FEMA to increase the effectiveness of its leadership role.

As far as the utilization of research, we work very hard to see that the results of our research are placed in the hands of the potential users. Every year we hold two to four workshops in cooperation with FEMA and other agencies in which we bring together scientists with the local and the program people, so that the scientists can explain his or her results for the latter.

As an example of this two-pronged approach, I have here a collection of scientific papers entitled, "Investigations of the New Madrid, Missouri Earthquake." They are papers on what we have learned about the origin and the causal structure.

I also have a companion volume entitled, "Report of a Workshop on Continuing Actions To Reduce Losses From Earthquakes in the Mississippi Valley Area," which was a workshop designed to translate the results of the scientific studies to practical plans and emergency preparedness.

During the workshop, plans for implementing earthquake hazard reduction procedures were developed.

This ends my oral statement. We look forward to continued participation in the earthquake hazard reduction program.

Mr. WALGREN. Thank you very much, Dr. Peck.

[The prepared statement of Dallas L. Peck follows:]

WRITTEN STATEMENT OF DR. DALLAS L. PECK, DIRECTOR

U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

SUBMITTED TO THE

HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

MARCH 15, 1983

INTRODUCTION

This statement is submitted in response to the invitation of February 24, 1983, from the Honorable Doug Walgren to Dr. John Filson of the U.S. Geological Survey (USGS) to participate in a hearing on the reauthorization of the Earthquake Hazards Reduction Act of 1977. We request that this statement be included in the record of the hearing.

PURPOSE AND SCOPE

The purpose and scope of this testimony, the fourth on this subject we have submitted to this Committee, are somewhat different than those of our earlier statements. In previous statements we have set down in some detail the activities of the USGS under the National Earthquake Hazards Reduction Program

(NEHRP). We shall not repeat the detailed information provided previously on the nature of our efforts but rather, after a brief review of the background of earthquake work in the USGS, focus our discussion on the other issues raised in Congressman Walgren's kind invitation--budget considerations and earthquake prediction--and on matters regarding the overall Federal program and research utilization.

BACKGROUND

Most of the earthquake related work within the Geological Survey falls under Objective (2) of the Earthquake Hazards Reduction Act, that is:

> "the implementation in all areas of high or moderate seismic risk, of a system (including personnel, technology, and procedures) for predicting damaging earthquakes and for identifying, evaluating, and accurately characterizing seismic hazards.".

To make clear the responsibility of the Geological Survey with respect to earthquake prediction, the 1980 amendments to the Earthquake Hazards Reduction Act gave the Director of the USGS authority to issue an earthquake prediction or other earthquake advisory as he deems necessary. This reinforced the authority given to the Director of the USGS under the Disaster Relief Act of 1974 to issue warnings for an earthquake, volcanic eruption, landslide, or other geologic catastrophe. Since 1978 seven earthquake advisories have been issued by the Director of the USGS regarding four separate regions of the United States. We have reviewed these points to emphasize that the USGS has major responsibilities relative to the issuance of earthquake warnings and, in fact, warnings of all geologic hazards, and that we are actively responding to these responsibilities. Although the USGS is often considered as an organization engaged chiefly in research, we have given and shall continue to give the application of our research to more accurate and more useful warnings and assessments of all geologic hazards high priority and importance within our organization.

BUDGET

Since the passage of the original legislation in 1977, the funding for the earthquake program has remained fairly constant. Table 1 (below) shows the funds (in millions of dollars) authorized and appropriated for earthquake hazards reduction work within the USGS for the past 6 years.

TABLE 1

Fiscal Year	78	79	80	81	82	83	84
Authorization	27.5	35.0	40.0	32.5	34.4	31.8	
Appropriation	30.2	28.0	31.6	32.3	32.7	34.5(1)	29.5(1,2)

Funding shown in millions of dollars

(1) Includes $1.2M transferred from the National Science Foundation to the USGS to support work previously done on a reimbursable basis.

(2) FY 84 funding is the President's proposed budget.

The earthquake program budget reduction proposed for FY 1984 reflects the Administration policy to hold Federal discretionary spending in check and the requirements of programs with equal or higher priority within the Geological Survey. Such programs are those involving mineral or land assessment surveys; however, even some of these programs are planned for reduction in FY 1984.

In planning for a reduction in support for the earthquake program, consideration has been given to keeping a core team of scientific personnel intact, maintaining the continuity and integrity of basic data sources, and continuing to provide information, assessments, and warnings to the public on earthquake occurrences and hazards. Given these choices our strategy is to allow the cadre of scientists working in the areas of earthquake prediction and earthquake potential estimation to decrease by attrition, to reduce theoretical and laboratory studies in those areas, to reduce the density and areal extent of geophysical monitoring networks in areas considered to be at lower risk, and to maintain the earthquake hazard assessment and public information and warning activities at a constant level.

Within our FY 1984 budget we shall continue support of the National Earthquake Information Service and the worldwide and nationwide data collection, analysis, and dissemination activities associated with that center. We shall continue to operate networks of instruments designed to record only strong ground shaking from large earthquakes. This data is extremely valuable to engineers and architects involved in seismic-resistant design. A program of regional earthquake hazards assessments, important to the mitigation of hazards in the long term, will continue. These studies are straightforward, relative to earthquake prediction research, and do not involve high operating expenses.

In the area of earthquake prediction research, reductions will be taken in the support of theoretical and laboratory research and to some degree in data collection in those regions thought to be at lower risk. We shall, to the extent possible, maintain our geophysical and geochemical monitoring efforts along and near the San Andreas fault in central and southern California. Based on quantitative assessments of earthquake potential, these areas of the United States are most likely to give rise to damaging earthquakes within the next few decades. Nevertheless, in order to continue high priority studies in areas of moderate seismicity such as the Salt Lake City, Puget Sound, and the St. Louis-Memphis regions, some adjustment in monitoring of less seismically active areas in California may be necessary.

EARTHQUAKE PREDICTION

Review

The goal of earthquake prediction is to give a warning of large, damaging earthquakes at a time interval long enough to allow appropriate actions by the public and private sectors. On the other hand, the time and location associated with the prediction must be given with enough precision to avoid sustained disruptive effects that the prediction response may have on society.

Ideally, we would like to predict, with high confidence, damaging earthquakes at specific locations and times 10 years before the event. With our current understanding, earthquake prediction is likely to resemble the forecasts of many phenomena; the precision of the forecast in time and space increases as the time interval between the present and the anticipated event decreases.

The average interval between major earthquakes on the southern San Andreas fault near Los Angeles, California, is estimated to be about 140 years with a 30-year uncertainty in this average. The ability to make such estimates is one of the major advances of the earthquake program during the past 5 years. The concept of the seismic cycle has developed in which strain is continuously stored near the boundaries of slowly moving sections or plates of the Earth's crust. The strain is released suddenly by slippage along faults at interplate boundaries giving rise to earthquakes. The interplate boundaries have been shown to have characteristics that vary with location. Some regions are characterized by long intervals between large earthquakes, others by more frequent and less severe earthquakes, the net energy release remaining the same in both cases.

If the length of the seismic cycle (or interval between large earthquakes) in southern California is 140 years on average, and a useful prediction must be accurate to within say 7 days, we must estimate the ending of the seismic cycle with an accuracy of about 99.99 percent. The fact that the length of the average time between large earthquakes can be estimated to only within 30 years, or 80 percent, makes the prognosis for precise, long-term earthquake predictions, made years in advance of the actual event, rather discouraging. Nevertheless, regional earthquake potential assessments based on average recurrence rates can be very useful in assigning priorities for general earthquake hazard mitigation activities.

If earthquakes are considered to be the failure of a mechanical system (the Earth's crust) under strain, then there is cause for hope that reliable and useful short-term earthquake predictions can be made. The argument is that when mechanical systems fail they often give some precursory physical sign that failure is imminent. A stick that is being bent will pop and crack just before it breaks. Materials that are being stressed at a constant rate in the laboratory will deform at a different rate just before failure. The strategy for successful earthquake prediction must be based on observing and understanding those phenomena that occur in the Earth's crust just before the catastrophic failure of the crust in a large earthquake.

To complicate the problem, the physical processes that culminate in an earthquake take place at depths of up to 30 miles in the crust and are hidden from direct view. Scientists involved in forecasting the weather can make direct observations in three-dimensions of the atmospheric conditions. In earthquake prediction we measure only the surficial effects of phenomena that take place within the crust with little hope of ever observing these processes directly. The fact that we measure effects of effects (or second-order phenomena) makes the problem more difficult to solve.

As pointed out above, large destructive earthquakes are relatively infrequent phenomena. Large earthquakes near dense networks of geophysical instrumentation are rare. Where hurricane forecasters may get a few opportunites each year to check and refine their theories, the opportunities to test prediction theories for large earthquakes are a few a century and the data base upon which to base a prediction is short and sparse.

To summarize, earthquake prediction is not a fully developed subject that can be implemented by simply employing existing scientific knowledge, technical skill, and engineering principles. The physical processes that culminate in an earthquake are generally hidden from view but are likely to be similar to those processes found in the failure of strained mechanical systems. However, the specific physical laws governing earthquake occurrence are not as well understood as, say, those governing the weather. Compared to weather forecasting, there are relatively few opportunities to obtain data with which to test and develop theories for earthquake prediction.

Earthquake Prediction Systems

Because of the likelihood of a major earthquake in California and because of the size of the population at risk there, we have concentrated the phenomenological study of earthquake prediction in that State. Over 60 percent of earthquake prediction program funds are used to support monitoring efforts in California. These efforts incude:

- The operation of over 500 seismograph stations (figure 1).
- Twenty-five geodetic strain monitoring networks containing several hundred survey lines (figure 2).

- Crustal deformation and fault offset monitoring at over 200 sites (figure 3).

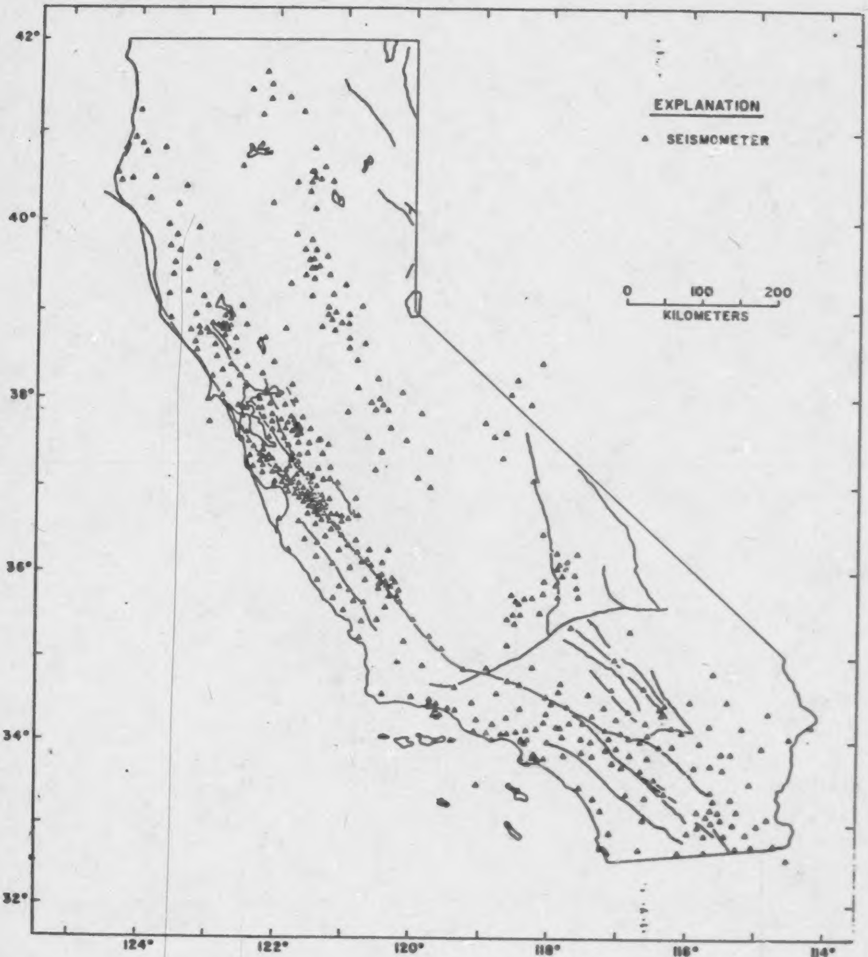
- Various other geochemical and geophysical observations at approximately 150 additional sites (figure 4).

Although these instruments are maintained by competent personnel and the data interpreted by dedicated scientists, these efforts cannot be looked upon as an operational earthquake prediction network for the following reasons:

- The most crucial element of an operational or prototype earthquake prediction system is the science itself. There does not exist today a simple equation for issuing an earthquake prediction. Earthquake advisories have been issued in the past, and will continue to be issued, based on our best judgment at the time, but we do not yet have the experience or knowledge that will allow systemizing earthquake predictions. Because such knowledge and experience are based on scientific advances and the occurrence of earthquakes themselves, it is difficult to estimate when such a systemization of earthquake prediction will be possible.

- In some cases the data are not continuously recorded or transmitted to a central data center, although this deficiency is being corrected.

FIGURE 1


42°
40°
38°
36°
34°
32°
124°
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114°
EXPLANATION
▲ SEISMOMETER
0 100 200
KILOMETERS

FIGURE 2

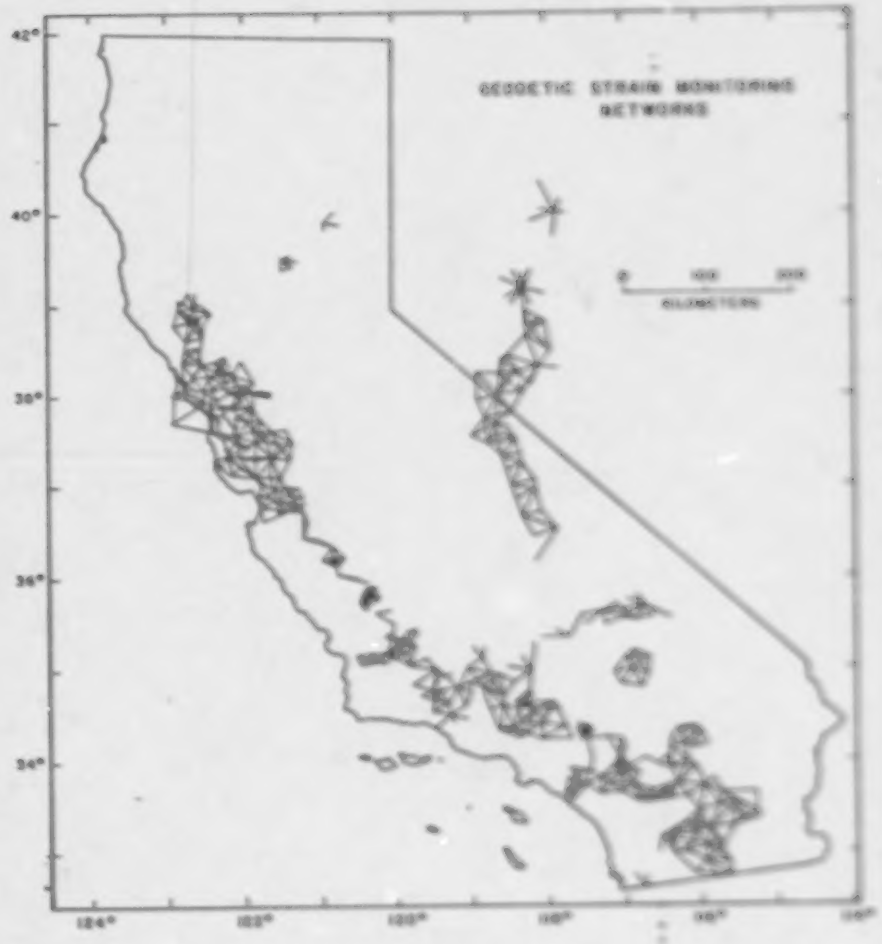
GEODETIC STRAIN MONITORING
NETWORKS
0
100
200
KILOMETERS
42°
40°
38°
36°
34°
124°
122°
120°
118°
116°
114°

FIGURE 3

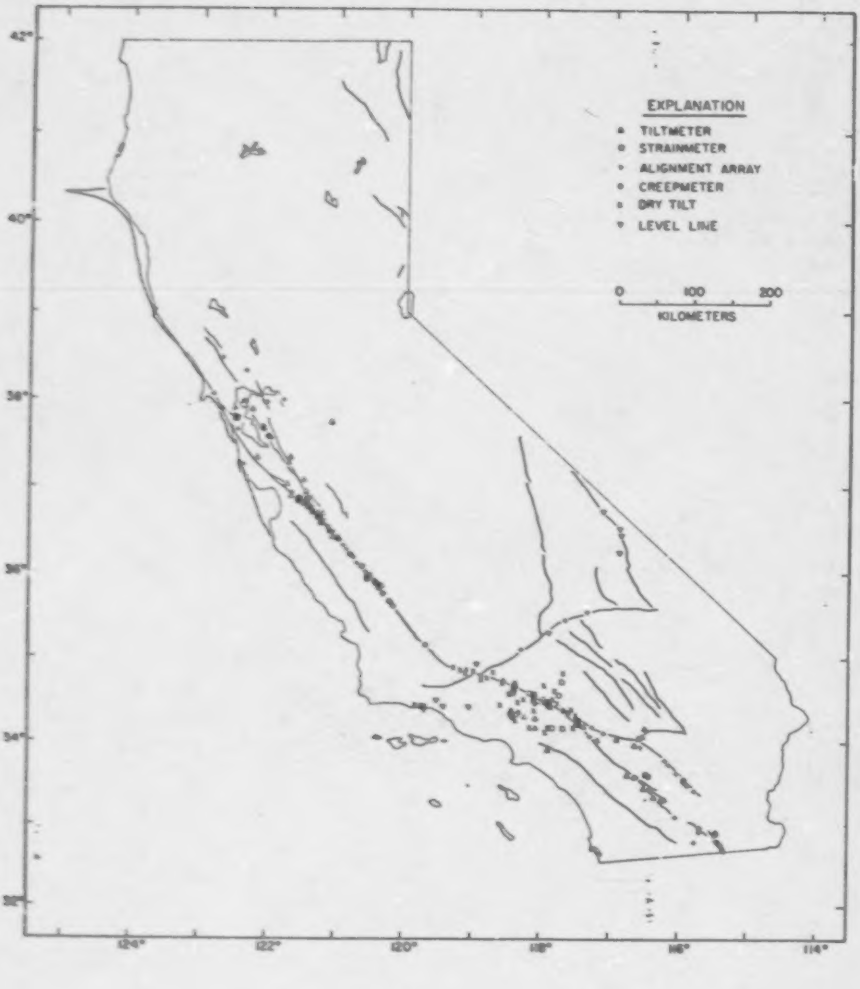
EXPLANATION
TILTMETER
STRAINMETER
ALIGNMENT ARRAY
CREEPMETER
DRY TILT
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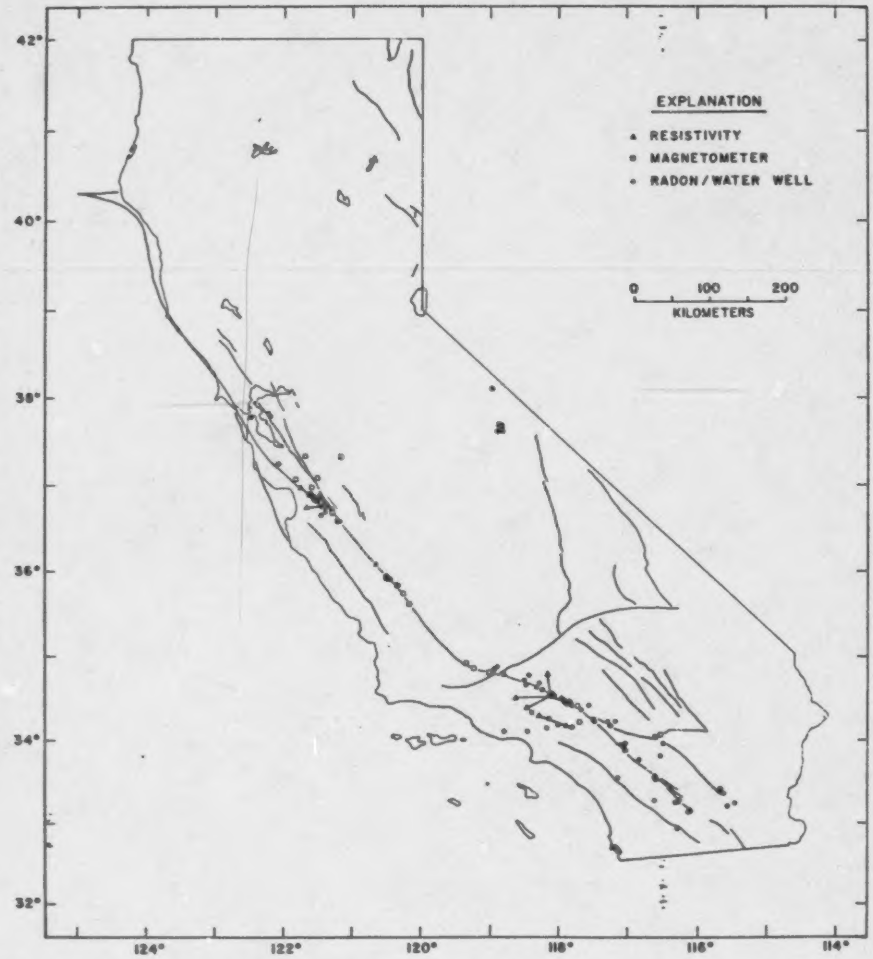
FIGURE 4


EXPLANATION
▲ RESISTIVITY
● MAGNETOMETER
• RADON/WATER WELL
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42°
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- In the cases where the data are continuously transmitted to a data center, they are transmitted over commercial telephone circuits of variable reliability.

- At most of the sites the instruments are placed on or near the surface of the Earth, as opposed to being placed in deep (1 km) boreholes to avoid the effects of the annual and daily cycles of weather and temperature.

On the other hand, the data processing activities associated with some of the earthquake prediction data are fairly sophisticated. Although not all of the data gathered from the field are transmitted to a data center, the data that are transmitted to data centers are automatically digitized and entered into computers for further analysis. Data centers are maintained at Pasadena (for southern California data) and Menlo Park (for central California data) where transmitted data are kept in computer files and displays summarizing all data maintained. Data that are not transmitted electronically to a data center must be physically collected from the field, and may be up to 2 months old before they are incorporated into the data displays. Data review meetings are held periodically, and on an ad hoc basis if necessary, to assess the situation, to deploy additional instrumentation or to perform special analysis if deemed necessary.

There are two approaches that can be taken to an "operational" prototype earthquake prediction system for southern California.

The first approach is the one we are embarked on now where instruments deployed for research purposes and analytical techniques developed in that research are incorporated into routine analysis and warning procedures. Those instruments and techniques that are proven unreliable or irrelevant to earthquake prediction are dropped in favor of more useful activities. We believe this course will provide the data that will be most useful in predicting the next major earthquake in southern California and at the same time provide for the research that will allow for interpretation of the data to be made with accuracy and understanding.

A less evolutionary approach, one that has been adopted in Japan, is to immediately deploy dense arrays of geophysical instrumentation in deep holes isolated from surface effects. Data from these instruments would be transmitted to data centers over dedicated, robust communication links. The data centers would be manned 24 hours a day and sophisticated data storage, display, and analysis facilities would be available. We are developing a conceptual design for a system of this type and plan to support further engineering studies of such a system this year. We believe it is prudent to have these design studies available in case of major scientific advances that would greatly increase our confidence in the effectiveness of such a system. However, given the apparent high cost of such a system and our lack of a more complete understanding of the physical processes that occur immediately before large earthquakes, we do not recommend that this approach be carried further than the design phase at this time.

Thus the question of when will an earthquake prediction system for southern California be "operational" cannot be given a simple answer. It depends on the rate at which we gain experience with understanding the physics of earthquake occurrence. The national effort to put a man on the Moon was the application of high and sophisticated technology to a set of fairly well-known physical laws. In earthquake prediction we are still trying to develop a clearer understanding of the latter, and we believe it is premature to advise a massive application of the former.

ORGANIZATION OF THE FEDERAL PROGRAM

In 1981 the Federal Emergency Management Agency (FEMA) was assigned the role as lead agency to "plan and coordinate" the NEHRP. During the last year we feel that major strides forward have been made in working more closely with FEMA and the execution of a coordinated program. Examples of this increased degree of dialogue and coordination are:

(1) During the past year the Director of the USGS has met on four occasions with Lee Thomas, Associate Director of FEMA for State and Local Programs, to discuss problems facing the NEHRP. Each of these meetings has proven extremely valuable in the coordination and the direction of the program. In fact, they have proven so valuable that we have tentatively agreed to meet on a regular quarterly basis with key representatives from the National Science Foundation and the National Bureau of Standards to continue to increase the discussion and coordination of the NEHRP at a high level in our respective agencies.

(2) A Memorandum of Understanding (MOU) has been signed between the USGS and FEMA outlining areas of responsibilities and future cooperation between the two agencies. This MOU was the result of a 2-day meeting in Reston during October 1982, in which discussions between our staffs were comprehensive and candid. These discussions identified four specific areas that deserve particular attention and for which annexes to the MOU are being developed. These areas are:

- Effective, coordinated response by FEMA and the USGS to a potential or existing geologic or hydrologic hazard.
- Dissemination of information on predictions or advisories of geologic or hydrologic hazards.
- Public preparation, education, and response to hazard information and predictions.
- Implementation of long-term hazard mitigation practices.

(3) After informal discussions between our staffs, we have recently received a request from FEMA that a USGS seismologist be detailed to FEMA to assist both our agencies in the coordination and execution of the NEHRP. We are proceeding to identify candidates for this position and hope to have one of our scientists in place at FEMA within the next few months.

Given these examples, we believe it may be asserted that the USGS and FEMA are taking a series of positive actions toward closer coordination of their efforts and the definition of FEMA's leadership role within the NEHRP.

At present, budget preparation and the appropriation of funds are done independently in each of the agencies participating in the NEHRP. We cannot speak for the other agencies involved but our view is that this arrangement should be maintained while drawing on the close communication ties that have been estabished and are described above. As indicated earlier in this statement, the USGS conducted earthquake prediction and hazard reduction studies before the passage of the 1977 legislation and the Director of the USGS had responsibilities and authorities involving warnings of geologic hazards independent of the Earthquake Hazards Reduction Act.

In summary on this issue, we feel that substantive progress has been made in our degree of cooperation and planning with FEMA and that the results of this progress should be allowed to work within the existing budgetary and funding authorities of the individual agencies participating in the NEHRP.

MITIGATING THE EFFECTS OF EARTHQUAKES

In the Committee hearings last year concern was expressed that the research programs in NSF and in USGS have developed considerably more technical and scientific knowledge than is being utilized. We share the Committee's concern in this area and have concluded that the production of research results and their publication in reports and journals does not ensure their application. We have further concluded that mailing a report on earthquake hazards to State or local officials is not enough. Our present approach is to bring the scientists, the producers of the information, the State and local officials, and the users of the information, together in a series of workshops so that the nature of the information and its applicability can be explained in face-to-face sessions.

Actions we have taken to increase the utilization of our research include:

(1) A position of Deputy Chief for Research Application has been created within the Office of Earthquakes, Volcanoes, and Engineering to facilitate and focus the responsibility for research utilization.

(2) The USGS conducted a workshop in Knoxville, Tennessee, in September 1981 on, "Preparing for and Responding to a Damaging Earthquake in the Eastern United States." This workshop brought together, for the first time, 70 individuals representing local, State, and Federal government, business and industry, and the research community.

(3) As a follow-up to the Knoxville effort, a workshop was held in St. Louis in May 1982 on "Continuing Actions to Reduce Losses from Earthquakes in the Mississippi Valley Area." A report of this workshop has been prepared (USGS Open-File Report 83-157) to set down the results of the meeting. A companion report on the seismicity of the New Madrid, Missouri, seismic region has been published (USGS Professional Paper 1236) that summarizes the results of our scientific studies in the area. These two reports document two complementary actions required for the mitigation of earthquake

hazards. The scientific studies and the planning at State and local levels are required to use the results of the scientific work.

(4) Three additional workshops are planned in 1983 to continue to foster earthquake hazard mitigation in the Eastern United States. These will be held in Charleston, South Carolina; Boston, Massachusetts; and Little Rock, Arkansas.

We are fortunate that support for these workshops is shared between the USGS and other agencies such as FEMA, NSF, and the Nuclear Regulatory Commission. Nevertheless, the USGS plans, conducts, and reports the results of these workshops, and thus we take considerable pride in this strong initiative in research utilization.

This concludes our statement on the issues facing the Geological Survey in the execution of its responsibilities under the National Earthquake Hazards Reduction Program. Although significant scientific problems remain, considerable progress has been made in the past 6 years. Problems of managing a complex program, research utilization, and warning and prediction systems have been identified and are being addressed in a forthright manner.

As these issues are joined, we look forward to further progress in earthquake hazards reduction.

Mr. **Walgren**. We will turn, then, to Assistant Director Sanderson of the National Science Foundation.

I am sorry to have to excuse myself at this point, but I look forward to reading your statement and working with you on it.

[The biographical sketch of Dr. Sanderson follows:]

JACK T. SANDERSON
Assistant Director for Engineering

National Science Foundation
Washington, D.C. 20550

Dr. Jack T. Sanderson became Assistant Director for Engineering when this Directorate was established on March 8, 1981.

Dr. Sanderson had previously served as Assistant Director for Engineering and Applied Science, Assistant Director for Applied Science and Research Applications, Assistant Director for Research Applications, Director of the Office of Planning and Resources Management, and Acting Deputy Assistant Director for Science Education. Before joining the Foundation in 1971, Dr. Sanderson had been lecturer, Director of the Cyclotron Laboratory, and Assistant Director of the Physics Laboratories at Harvard University.

Dr. Sanderson's primary research areas have been in solid state physics, especially nuclear magnetic and electron paramagnetic resonance, low temperature and nuclear orientation. He has also done experiments in high-energy proton and electron scattering.

Dr. Sanderson was born in Russellville, Alabama. He received an A.B. in physics and chemistry at Harvard University in 1958 and was awarded a Master's and a Ph.D. at Harvard in 1967.

He is a member of the American Physical Society, the American Association for the Advancement of Science, the American Society for Engineering Education, the Cryogenic Society, and Sigma Xi.

Dr. and Mrs. Sanderson and their two daughters, Caroline and Nicole, reside in Alexandria, Virginia.

June 1983

STATEMENT OF JACK T. SANDERSON, ASSISTANT DIRECTOR OF ENGINEERING, NATIONAL SCIENCE FOUNDATION

Dr. SANDERSON. With my formal statement in the record, I would like to summarize briefly.

The Foundation, as you are aware, has been assigned primary responsibilities in the area of seismic research in the basic Earth sciences and earthquake engineering and in societal response activities.

Since 1977, the Foundation has obligated about $135 million for research in these three areas, about 80 percent in the engineering and societal response activity and about 20 percent in the Earth sciences. During this interval significant advances have been made in all three areas.

The understanding of plate tectonics, blockage, and slippage of the plates, and the fundamental properties of earthquakes has placed the conceptual understanding of earthquake sites, causes, and features on a sound basis.

In the societal response area, we have sponsored research projects in a number of areas, particularly in recent years looking at forces and ground motion at a specific site through theoretical models that relate these forces to the location, the properties of the soil and the rock structures, and to the fundamental nature of the earthquake fault itself. Through both the theoretical and experimental programs, we are developing better techniques for aseismic design that have now been applied in a number of areas, such as high-rise construction and other types of construction in seismic zones, particularly along the west coast. That information is now being slowly but surely incorporated into building codes as they are being revised.

In the societal response area, we have sponsored research projects in a number of areas, particularly in recent years looking at postdisaster recovery and the steps that it takes to put an economy and society back on its feet after a major catastrophe such as the earthquake which occurred in Italy.

At the same time, we have been placing significant emphasis on the transfer of our research activities from the basic research community into the hands of the users through workshops that we have funded, through conferences that bring in practicing members of the engineering community, and through other selected projects designed to demonstrate the new techniques that have been developed.

Currently, one area that we are rather enthusiastic about is the opportunity to introduce into this country seismic isolation in the construction of major buildings. We are working with a group of city officials in San Bernandino County to introduce the use of or essentially shock-mounted building, so that the ground can vibrate underneath the building but the building, its contents, and occupants will be isolated through plates or rubberlike mounts that absorb the energy.

This has two advantages. First, by absorbing the energy in these mounts, the amount of steel and structural materials that must go into the building is reduced for a given degree of safety. Second, it has the advantage of reducing the damage to the occupants and contents since they are not shaken around as they would be even if a more conventionally designed building itself remained structurally intact.

In carrying out these activities, we have been coordinating closely with FEMA and the other Federal agencies involved in this area and with the research community.

Among the activities we have sponsored has been a followup study by the National Research Council, chaired by Dr. George Housner, to prepare a second report evaluating progress that has been made on earthquake engineering research. The first study in 1969, also chaired by Dr. Housner, was prepared more than a decade ago on the needs and opportunities in seismic research.

We have accomplished most of these activities by incorporating a strong flavor of international cooperation. This has been necessitated by two major events. First, there are opportunities to use large-scale experimental facilities which are nonexistent in the United States but which offer the potential for carrying out significant research activities that are essential to our understanding of scaling laws. The research has been carried out primarily with the Japanese and has resulted in both the verification of much of our understanding of scaling laws between the laboratory models and the actual buildings themselves, and at the same time identifying some potential limits to the use of scaling in predicting the behavior of the large structures. As the laboratory model becomes smaller, it becomes more difficult to accurately replicate the properties of the materials used in the construction.

The second primary area of international cooperation has been in gathering data on earthquake events so that we can understand the forces better. Here we have active programs going with the People's Republic of China, Taiwan, Mexico, and a number of other countries which are located in seismically active zones of the globe. As a result of this, we have been able to accumulate data on the actual earthquake events at a much more rapid rate than would be possible were we dependent on our own facilities within the United States.

These programs are going well. There are clearly a number of exciting and important areas that we will be pursuing in the future, among them the problems of retrofitting the large existing stock of U.S. buildings and housing which do not meet modern standards for aseismic construction and the problems of dealing with lifeline facilities, that is, distributed facilities such as gaslines, plumbing, electrical lines, which have unique characteristics because their dimensions are equal to or larger than the typical wavelength of a seismic event. We anticipate that this research will be done in cooperation with our fellow agencies and that we will continue to make progress in this important area.

With that, I think I would like to respond to questions at the appropriate time, Mr. Chairman.

[The prepared statement of Dr. Jack T. Sanderson follows:]

STATEMENT BY DR. JACK T. SANDERSON
ASSISTANT DIRECTOR, ENGINEERING
NATIONAL SCIENCE FOUNDATION (NSF)
BEFORE THE
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES
MARCH 15, 1983

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

SINCE PASSAGE OF THE EARTHQUAKE HAZARDS REDUCTION ACT IN 1977, NSF HAS ACCELERATED RESEARCH IN THIS AREA. OBLIGATIONS DURING THIS PERIOD HAVE BEEN APPROXIMATELY $135 MILLION, WITH APPROXIMATELY 80% OF THE EXPENDITURES BEING MADE BY THE ENGINEERING DIRECTORATE (ENG) AND THE REMAINING 20% BY THE DIRECTORATE FOR ASTRONOMICAL, ATMOSPHERIC, EARTH, AND OCEAN SCIENCES. TODAY I AM PLEASED TO REPORT ON THE SIGNIFICANT AND RAPID ADVANCEMENTS BEING MADE IN ENGINEERING, ARCHITECTURE, PLANNING, SEISMOLOGY AND SOCIETAL RESPONSE BECAUSE OF THE NSF PROGRAMS.

THE EXISTING ALLOCATION OF RESPONSIBILITIES AMONG THE VARIOUS AGENCIES INVOLVED IN THE NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM IS WELL ESTABLISHED. WE ALSO FIND APPROPRIATE THE ORGANIZATIONAL STRUCTURE CONSISTING OF THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) AS THE LEAD AGENCY WITH THE OTHER PARTICIPATING AGENCIES, EACH HAVING ITS OWN BUDGET WITHIN THE AGENCY APPROPRIATION.

THE EARTHQUAKE PROBLEM IS TRULY NATIONAL IN SCOPE BECAUSE MOST STATES HAVE SOME DEGREE OF SEISMIC RISK. FURTHER, STUDIES BY THE U.S. GEOLOGICAL SURVEY (USGS) INDICATE THAT THE PROBABILITY OF A LARGE EARTHQUAKE IN CALIFORNIA IS INCREASING EACH YEAR.

ALTHOUGH THE GREATEST SEISMIC HAZARD IS PRESENTLY BELIEVED TO BE ON THE WEST COAST, RECENT CONCERN HAS BEEN EXPRESSED ABOUT POSSIBLE EARTHQUAKES IN THE EASTERN U.S., SIMILAR TO THE 1811-12 NEW MADRID, MISSOURI, AND THE 1886 CHARLESTON, SOUTH CAROLINA, EARTHQUAKES. SHOULD EARTHQUAKES OCCUR IN A MAJOR METROPOLITAN AREA, EXTENSIVE PROPERTY DAMAGE AND LOSS OF LIFE COULD RESULT, PARTICULARLY WHEN MAN-MADE FACILITIES ARE NOT SEISMICALLY RESISTANT.

I WILL DISCUSS THE RESEARCH ACTIVITIES WITHIN THE DIVISION OF EARTH SCIENCES (AAEO) AND THE PROBLEM-FOCUSED EARTHQUAKE HAZARD MITIGATION PROGRAM (EHM) WHICH RESIDES IN THE DIVISION OF CIVIL AND ENVIRONMENTAL ENGINEERING (ENG).

FUNDING FOR THE PROGRAM IN THE AAEO DIRECTORATE FOLLOWED OPTION B OF THE GUIDELINES SET BY THE 1976 NEWMARK-STEVER REPORT THROUGHOUT THE DURATION OF THOSE GUIDELINES. IN FY 1983 WE ARE FUNDING THAT PROGRAM AT $7.5 MILLION. THE FUNDING REQUESTED FOR FY 1984 IS $8.3 MILLION, AN INCREASE OF 10.6%.

IN THE AAEO DIRECTORATE, THE FUNDAMENTAL EARTHQUAKE STUDIES ELEMENT IS SUPPORTED PRIMARILY THROUGH THE SEISMOLOGY AND DEEP EARTH STRUCTURE PROGRAM OF THE DIVISION OF EARTH SCIENCES. SEISMOLOGY IS THE PRIMARY METHOD OF STUDYING THE STRUCTURE AND PHYSICAL PROPERTIES OF THE EARTH'S INTERIOR AND OF DEFINING THE PLATES MAKING UP THE EARTH'S LITHOSPHERE. AS SUCH, SEISMOLOGY AND OTHER EARTHQUAKE RELATED TOPICS HAVE CONSTITUTED AN IMPORTANT PART OF THE DIVISION'S PROGRAM FOR SOME 20 YEARS. THIS RESEARCH CONSISTS OF DETAILED STUDIES AND MEASUREMENTS DIRECTED AT UNDERSTANDING THE NATURAL PHENOMENA INVOLVED IN AN EARTHQUAKE. THE MAJOR GOAL IS TO PROVIDE THE BASIC SCIENTIFIC FRAMEWORK ON WHICH MORE EMPIRICAL PROGRAMS OF EARTHQUAKE PREDICTION CAN BE BASED.

THIS PROGRAM OF FUNDAMENTAL SEISMOLOGICAL STUDIES AT NSF CAN BE DEFINED IN TERMS OF TWO BROAD CATEGORIES: PLATE TECTONICS AND THE EARTHQUAKE PROCESS. THE CONCEPT OF PLATE TECTONICS STATES A SMALL NUMBER OF RIGID PLATES FORM THE EARTH'S OUTER SURFACE AND

THE MOVEMENT OF THESE PLATES RELATIVE TO ONE ANOTHER IS RESPONSIBLE FOR EARTHQUAKES, VOLCANIC ERUPTIONS, AND MANY OTHER PHENOMENA. WHEN WE KNOW MUCH MORE ABOUT WHY AND HOW THE PLATES MOVE, WE WILL HAVE THE BASIS OF A MUCH BETTER UNDERSTANDING OF MANY PROCESSES IN THE EARTH, WHICH SHOULD LEAD TO THE PREDICTION OF EARTHQUAKES.

THE EARTHQUAKE PROCESS ITSELF IS LESS WELL UNDERSTOOD AND IS THE SUBJECT OF MUCH ATTENTION. WE DO NOT YET KNOW WHAT PHYSICAL PARAMETERS ARE THE MOST CRITICAL OR THE DETAILS OF ROCK PROPERTIES THAT CAUSE AN EARTHQUAKE. THE FAILURE CRITERIA OF CRUSTAL ROCKS AND THE ROLE OF PRE-EARTHQUAKE DEFORMATIONS MUST BE UNDERSTOOD IN ORDER TO CALCULATE THE RE-INITIATION OF MOTION ON THE FAULT AND TO DETERMINE THE TOTAL SEISMIC ENERGY THAT IS RELEASED. IN ADDITION, THE MATERIAL PROPERTIES AND THE NATURE OF THE GEOLOGY AFFECT THE AMOUNT OF ENERGY RELEASED AND THE CHARACTERISTICS OF THE GENERATED MOTION.

THE EHM PROGRAM, WHICH IS IN THE DIRECTORATE FOR ENGINEERING, HAS REMAINED INTACT SINCE THE EARLY 1970'S. AS REORGANIZATIONS WITHIN NSF HAVE OCCURRED OVER THE YEARS, THE EHM PROGRAM HAS FUNCTIONED WITH CONTINUOUS SUPPORT WITHIN THE DIRECTORATE OF RESEARCH APPLICATIONS (RA), THE DIRECTORATE FOR APPLIED SCIENCE AND RESEARCH APPLICATIONS (ASRA), AND THE DIRECTORATE FOR ENGINEERING AND APPLIED SCIENCE (EAS). FOR THE PAST TWO YEARS IT HAS RESIDED IN THE DIRECTORATE FOR ENGINEERING (ENG). FUNDING FOR THIS PROGRAM WAS INCREASED FROM $9.3 MILLION IN FISCAL YEAR 1977 TO $17.7 MILLION IN FISCAL YEAR 1978 FOLLOWING PASSAGE OF THE ORIGINAL ACT. IT HAS REMAINED ESSENTIALLY CONSTANT THROUGH FISCAL YEAR 1983. THE IMPORTANCE AND URGENCY OF THE EARTHQUAKE PROBLEM IN SOCIETY CAUSES US TO REQUEST AN INCREASE OF 9.8% FOR FISCAL YEAR 1984.

THE GENERAL OBJECTIVE OF THE EHM PROGRAM IS TO CONDUCT RESEARCH WHICH WILL LEAD TO MINIMUM PROPERTY DAMAGE AND LOSS OF LIFE FROM POTENTIALLY DAMAGING EARTHQUAKES. TO ACCOMPLISH THIS OBJECTIVE REQUIRES BROAD PARTICIPATION IN THE RESEARCH PROGRAM BY ARCHITECTS, URBAN PLANNERS, EARTH SCIENTISTS, GEOTECHNICAL ENGINEERS, STRUCTURAL ENGINEERS, AND SOCIAL SCIENTISTS. FOR BUDGET PURPOSES, THE EHM PROGRAM IS DIVIDED INTO THE THREE GENERAL RESEARCH AREAS OF SITING, DESIGN AND SOCIETAL RESPONSE WHOSE SPECIFIC OBJECTIVES ARE:

O SITING RESEARCH, WHICH SEEKS TO DETERMINE FROM INSTRUMENTATION AND GEOTECHNICAL DATA THE NATURE OF STRONG GROUND SHAKING DURING EARTHQUAKES, TO DEVELOP ANALYTICAL PROCEDURES TO PREDICT THE SPATIAL AND TEMPORAL DISTRIBUTION OF STRONG GROUND MOTION AT DIFFERENT SITES, TO UNDERSTAND THE DYNAMIC BEHAVIOR OF SOIL AND ROCK SUBJECT TO STRONG SHAKING, AND TO UNDERSTAND THE BEHAVIOR OF THE OCEAN, PARTICULARLY ITS MARGINS, DUE TO UNDERWATER EARTHQUAKES PRODUCING DAMAGING TSUNAMIS.

- O DESIGN RESEARCH, WHICH AIMS TO DEVELOP PROCEDURES FOR PERFORMING DYNAMIC ANALYSES OF PROPOSED OR EXISTING STRUCTURES UNDER EARTHQUAKE LOADINGS, TO DEVELOP AN UNDERSTANDING OF MATERIAL, COMPONENTS, AND STRUCTURAL SYSTEMS SUBJECTED TO DAMAGING DYNAMIC LOADS, AND TO DEVELOP PROCEDURES FOR THE ANALYSIS AND DESIGN OF NONSTRUCTURAL AND ARCHITECTURAL SYSTEMS SUBJECTED TO EARTHQUAKE LOADINGS.

- O SOCIETAL RESPONSE RESEARCH, WHICH STUDIES AND EVALUATES MEASURES THAT CAN BE USED TO MITIGATE SOCIETY'S LOSSES DUE TO EARTHQUAKES, INCLUDING EMERGENCY PREPAREDNESS, LAND USE PLANNING, BUILDING CODES, INSURANCE, AND INFORMATION AND EDUCATION, AS WELL AS OTHER ACTIONS COMMUNITIES CAN TAKE TO WITHSTAND EARTHQUAKES AND OTHER DISASTERS WITH MINIMAL IMPACT ON BOTH LIFE AND PROPERTY.

BECAUSE OF THE URGENCY IN MAKING PREPARATIONS FOR A MAJOR EARTHQUAKE, WE HAVE NOT BEEN CONTENT WITH ONLY REPORTING RESEARCH RESULTS IN TECHNICAL JOURNALS, BUT HAVE ATTEMPTED TO ACCELERATE THE UTILIZATION OF FINDINGS. THIS HAS REQUIRED EXTENSIVE INTERACTION WITH OTHER FEDERAL AGENCIES, AND WHEN APPROPRIATE, WITH STATE AND LOCAL OFFICIALS. FOR EXAMPLE, NSF CO-SPONSORED THE INTERNATIONAL EARTHQUAKE CONFERENCE THAT WAS HELD AT THE UNIVERSITY OF SOUTHERN CALIFORNIA ON FEBRUARY 7-11, 1983. SUPPORT FOR THE CONFERENCE WAS ALSO PROVIDED BY THE AGENCY FOR INTERNATIONAL DEVELOPMENT (AID), THE U.S. GEOLOGICAL SURVEY (USGS), AND THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA). THE CONFERENCE WAS DESIGNED FOR POLICY MAKERS AND ADMINISTRATORS IN LOCAL GOVERNMENTS FACING EARTHQUAKE RISKS. OVER 200 REPRESENTATIVES FROM SEVERAL SEISMIC-THREATENED COUNTRIES, INCLUDING THE PHILLIPPINES, ITALY, JAPAN, MEXICO, AND PERU ATTENDED THE CONFERENCE AND SHARED THEIR EXPERIENCE IN ATTEMPING TO UNDERSTAND, MITIGATE, AND PREPARE FOR DESTRUCTIVE EARTHQUAKES. THE MULTI-NATIONAL PRESENTATIONS AT THE CONFERENCE WILL RESULT IN THE PUBLICATION OF RECOMMENDATIONS FOR REDUCING EARTHQUAKE HAZARDS IN VULNERABLE URBAN AREAS THROUGHOUT THE WORLD.

THE RESEARCHERS PARTICIPATING IN THE EHM PROGRAM HAVE THE ADDED RESPONSIBILITY TO INTERACT WITH THE ULTIMATE USERS OF THE RESEARCH. THIS HAS BEEN EFFECTIVE BECAUSE THE EHM PROGRAM HAS ATTRACTED MANY OF THE MOST PRODUCTIVE AND RESPECTED RESEARCHERS AND ENGINEERS IN BOTH THE UNIVERSITIES AND THE PRIVATE SECTOR, MANY BEING MEMBERS OF THE NATIONAL ACADEMIES OF SCIENCE AND ENGINEERING. THE STATURE AND WIDE-RANGING INVOLVEMENT OF SUCH INDIVIDUALS AS CONSULTANTS TO OTHER GOVERNMENT AGENCIES AND PRIVATE SECTOR FIRMS HAVE PROVIDED A DIRECT MECHANISM FOR INTRODUCING RESEARCH RESULTS INTO PRACTICE.

IN A MORE TRADITIONAL MODE, THE EHM PROGRAM DISTRIBUTES ALL TECHNICAL REPORTS THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE (NTIS) AND HAS ESTABLISHED AND MAINTAINED THE NATIONAL

INFORMATION SERVICE FOR EARTHQUAKE ENGINEERING (NISEE) AT THE UNIVERSITY OF CALIFORNIA, BERKELEY, AND AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY. THESE FACILITIES ATTEMPT TO RETAIN ALL PERTINENT INFORMATION ON EARTHQUAKE ENGINEERING (INCLUDING DOCUMENTS FROM FOREIGN COUNTRIES) IN THE FORM OF TECHNICAL PUBLICATIONS, COMPUTER CODES, AND JOURNAL ABSTRACTS. SIMILAR CATALOGING OF PERTINENT INFORMATION ON THE SOCIAL SCIENCE ASPECTS IS MAINTAINED IN THE NATIONAL HAZARDS RESEARCH AND APPLICATION INFORMATION CENTER AT THE UNIVERSITY OF COLORADO. WE ALSO HAVE SUPPORTED NUMEROUS SEMINARS, WORKSHOPS AND CONFERENCES TO INTRODUCE THE USERS TO THE LATEST ADVANCEMENTS IN TECHNOLOGY.

COORDINATION WITH OTHER AGENCIES IS ACCOMPLISHED BOTH ON A FORMAL AND INFORMAL BASIS. DIRECT PARTICIPATION IN THE FOLLOWING ORGANIZATIONS HAS PROVIDED NSF EFFECTIVE MECHANISMS FOR COORDINATION:

- INTERAGENCY COORDINATION COMMITTEE ON NATIONAL EARTHQUAKE HAZARD REDUCTION PROGRAM (ICC/NEHRP)
- UNIVERSITIES COUNCIL ON EARTHQUAKE ENGINEERING RESEARCH (UCEER)
- EARTHQUAKE ENGINEERING RESEARCH INSTITUTE (EERI)
- U.S.-JAPAN COMMITTEE ON NATURAL RESOURCES (UJNR) - PANEL ON WIND AND SEISMIC EFFECTS
- COMMITTEE ON SEISMOLOGY (NAS-NAE-NRC)
- COMMITTEE ON NATURAL DISASTERS (NAS-NAE-NRC)
- INTERNATIONAL TUNNELING ASSOCIATION (ITA)
- CALIFORNIA SEISMIC SAFETY COMMISSION
- INTERAGENCY DISCUSSION GROUP ON DISASTER MITIGATION (IDGDM)
- INTERAGENCY COMMITTEE ON SEISMIC SAFETY IN CONSTRUCTION (ICSSC)
- BUILDING SEISMIC SAFETY COUNCIL (BSSC)
- EMERGENCY MOBILIZATION PREPAREDNESS BOARD-WORKING GROUP ON EARTHQUAKES (OSTP)
- NSF AND USGS ADVISORY COMMITTEES

TO FACILITATE AN UNBIASED EVALUATION OF THE EARTHQUAKE ENGINEERING RESEARCH NEEDS, A COMMITTEE IS BEING FORMULATED UNDER THE AUSPICES OF THE NATIONAL RESEARCH COUNCIL. IN ADDITION, A REVIEW GROUP, CONSISTING OF POLICY-LEVEL ADMINISTRATORS FROM NSF, U.S. GEOLOGICAL SURVEY, FEDERAL EMERGENCY MANAGEMENT AGENCY AND NATIONAL BUREAU OF STANDARDS, WAS RECENTLY ESTABLISHED FOR THE NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM, WHICH WILL PROVIDE FORMAL COORDINATION AMONG THE INVOLVED AGENCIES ON A PERIODIC BASIS. NSF ALSO WORKS CLOSELY WITH THE LEAD AGENCY (FEMA) IN PREPARING AN ANNUAL REPORT TO CONGRESS AND THE FIVE-YEAR PLAN FOR THE NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM.

EXTENSIVE INTERACTION AND JOINT RESEARCH PROJECTS WITH OTHER PARTICIPATING AGENCIES ARE ALSO AN INTEGRAL PART OF OUR PROGRAM. AN IMPORTANT ACTIVITY IN PAST YEARS HAS BEEN THE FUNDING BY NSF OF THE NATIONAL STRONG MOTION INSTRUMENTATION PROGRAM, WHICH IS CONDUCTED BY THE USGS. TO EFFECT BETTER COORDINATION, THE FUNDING FOR THIS ACTIVITY ($1.2 MILLION) WAS TRANSFERRED TO THE USGS IN FISCAL YEAR 1983, AND HENCE IS NOT INCLUDED IN THE BUDGET PROPOSED FOR FISCAL YEAR 1984.

WHILE EACH RESEARCH PROJECT IS MAKING A CONTRIBUTION TO OUR UNDERSTANDING AND MITIGATION OF EARTHQUAKES EFFECTS, I WOULD LIKE TO HIGHLIGHT A FEW OF THE MORE SIGNIFICANT RECENT ACHIEVEMENTS TO GIVE YOU AN IDEA OF THE WIDE RANGE OF ACTIVITIES IN WHICH WE ARE ENGAGED.

FIRST, SUBSTANTIAL ADVANCES HAVE BEEN MADE IN RECENT YEARS IN PLATE TECTONICS AND THE EARTHQUAKE PROCESS. THE FOLLOWING IS A BRIEF SUMMARY OF SOME OF THESE ADVANCEMENTS IN EACH OF THE TWO BROAD CATEGORIES OF FUNDAMENTAL SEISMOLOGICAL STUDIES AT NSF:

(1) PLATE TECTONICS

- O DELINEATION OF "SEISMIC GAPS" AND A MAP OF SEISMIC POTENTIAL FOR THE SIMPLE MAJOR PLATE BOUNDARIES OF THE WORLD.
- O INCREASED KNOWLEDGE OF THE NATURE OF SUBDUCTION ZONE EARTHQUAKES AND THE PHYSICAL PROCESSES BY WHICH THEY ARE GENERATED.
- O THE ASSOCIATION OF THE LOCATION OF PARTICULAR INTRAPLATE EARTHQUAKES WITH FAULTS AND OTHER TECTONIC FEATURES.

(2) THE EARTHQUAKE PROCESS

- O THE INTRODUCTION OF A NEW, MORE QUANTITATIVE MEASURE OF THE "SIZE" OF AN EARTHQUAKE, THE MOMENT.
- O A BETTER UNDERSTANDING OF THE DYNAMIC PROCESSES OF FAULTING -- HOW A FAULT RUPTURE NUCLEATES, SPREADS, AND FINALLY STOPS, AND THE EFFECTS SEEN IN SEISMOGRAMS FROM EACH OF THESE THREE STAGES IN THE FAULTING PROCESS.
- O THE DISCOVERY THAT A NUMBER OF MAJOR EARTHQUAKES HAVE BEEN PRECEDED BY A PREMONITORY CLUSTERING OF SMALL EARTHQUAKE EVENTS IN THEIR EPICENTRAL REGIONS.

SECONDLY, WITH RESPECT TO EARTHQUAKE ENGINEERING:

- O THEORETICAL ADVANCEMENTS AND COMPUTER TECHNOLOGY HAVE RESULTED IN MODELS CAPABLE OF REPRODUCING THE STRONG-MOTION SEISMOGRAMS RECORDED FOR PAST EARTHQUAKES. WHEN THE INPUT PARAMETERS FOR A SPECIFIC SITE HAVE BEEN DETERMINED, THESE GROUND MOTION MODELS WILL BE CAPABLE OF PREDICTING THE DAMAGING GROUND MOTIONS FOR A FUTURE EARTHQUAKE. THIS PROCEDURE WAS CONSIDERABLY ENHANCED WHEN MIT RESEARCHERS WERE ABLE TO MEASURE IN THE FIELD, FOR THE FIRST TIME, THE EARTHQUAKE RESPONSE OF SEDIMENT FILLED VALLEYS. THE MEASUREMENTS WERE MADE THROUGH A UNIQUE SET OF INSTRUMENT DATA FROM A COOPERATIVE RESEARCH PROJECT IN THE GARM DISTRICT OF THE REPUBLIC OF RAKJIKISTAN OF THE USSR.

- O TO VERIFY EXPERIMENTALLY NEW CONCEPTS AND DEVELOP AN UNDERSTANDING OF MATERIALS AND STRUCTURAL BEHAVIOR UNDER SEISMIC LOADING CONDITIONS, IT IS NECESSARY TO SIMULATE ACTUAL EARTHQUAKE GROUND MOTIONS. THIS HAS BEEN ACCOMPLISHED IN THE LABORATORY BY THE DEVELOPMENT OF ONE- AND TWO-DIMENSIONAL "SHAKE TABLES" AND CYCLIC TEST EQUIPMENT. A TECHNIQUE OF CONTROLLED DETONATION OF EXPLOSIVES ALSO HAS BEEN DEVELOPED (SRI) TO SIMULATE THE EARTHQUAKE GROUND MOTIONS UNDER FIELD CONDITIONS, AND DURING THE PAST YEAR, HAS BEEN IMPROVED TO SIMULATE STRONG EARTHQUAKE GROUND MOTIONS OF UP TO 15 SECONDS DURATION.

- O UNREINFORCED MASONRY BUILDINGS PRESENT THE GREATEST VULNERABILITY TO SEISMIC DAMAGE OF ANY OF OUR EXISTING STOCK OF BUILDINGS. RESEARCH INVESTIGATIONS INTO THE DYNAMIC RESPONSE OF UNREINFORCED MASONRY WALLS HAS PRODUCED THE NECESSARY DATA TO ENABLE THE CITY LOS ANGELES TO ENACT AN ORDINANCE REQUIRING OWNERS TO UPGRADE THEIR UNREINFORCED MASONRY BUILDINGS TO BE SEISMICALLY RESISTANT. OWNERS OF THE MORE THAN 9,000 UNREINFORCED MASONRY BUILDINGS ARE COMPLYING WITH THE ORDINANCE.

- O OF EXTREME IMPORTANCE FOLLOWING AN EARTHQUAKE IS THE SATISFACTORY PERFORMANCE OF LIEFLINES, I.E., GAS, WATER, SEWER, COMMUNICATIONS, TRANSMISSION LINES, HIGHWAYS, ETC. RESEARCH IS BEING DIRECTED AT THE TOTAL LIFELINE PROBLEM FOR A METROPOLITIAN AREA AS WELL AS FOR SPECIFIC AREAS.

- O NSF IS ALSO PARTICIPATING IN A PROJECT THAT INVOLVES THE INTRODUCTION TO THIS COUNTRY OF THE NEW METHOD OF MAKING A STRUCTURE SEISMICALLY RESISTANT, NAMELY BASE ISOLATION. THIS PROCEDURE WAS STUDIED IN EARLIER RESEARCH PROJECTS. IT IS PROPOSED THAT IT BE USED IN A NEW PUBLIC BUILDING IN SAN BERNADINO, CALIFORNIA.

BOTH POLICY MAKERS AND OPERATING UNITS FROM A RANGE OF ORGANIZATIONS HAVE BENEFITED FROM THE USEFUL RESEARCH ON THE SOCIAL AND ECONOMIC ASPECTS OF HAZARD REDUCTION STRATEGIES. THE RESULTS FROM THIS RESEARCH HAVE BEEN USED BY LOCAL, STATE, AND NATIONAL ORGANIZATIONS TO IMPROVE MITIGATION AND PREPAREDNESS EFFORTS AND TO DEVELOP DISASTER WARNING AND POST-DISASTER RECOVERY MEASURES. THIS SOCIETAL RESPONSE ELEMENT OF THE EHM PROGRAM FOCUSES ON THE SOCIOECONOMIC ASPECTS OF PRE-DISASTER ACTIVITY, SUCH AS HAZARD REDUCTION, AS WELL AS SUCH POST-DISASTER ACTIVITY AS RECOVERY. IN THE PAST YEAR, NSF-SPONSORED PROJECTS HAVE MADE SIGNIFICANT CONTRIBUTIONS TO OUR KNOWLEDGE OF DISASTER RECOVERY.

- FREDERICK BATES AT THE UNIVERSITY OF GEORIA COMPLETED A STUDY ON LONG-TERM RECOVERY FROM THE 1976 GUATEMALAN EARTHQUAKE, PAYING PARTICULAR ATTENTION TO LESSONS THAT COULD BE LEARNED IN PREPARING FOR SIMILAR DESTRUCTIVE EARTHQUAKES IN THIS COUNTRY.

- ROCCO CAPORALE OF ST. JOHN'S UNIVERSITY INITIATED A MAJOR FIELD STUDY ON RECONSTRUCTION AND RECOVERY FOLLOWING THE 1980 ITALIAN EARTHQUAKE AND THE IMPLICATIONS OF THIS EXPERIENCE FOR VULNERABLE AREAS IN THE UNITED STATES.

- PETER ROSSI AND HIS COLLEAGUES AT THE UNIVERSITY OF MASSACHUSETTS COMPLETED THE FIRST NATIONWIDE STUDY OF DISASTER VICTIMIZATION. THIS STUDY, ALONG WITH A COMPLEMENTARY ONE COMPLETED BY ROBERT BOLIN OF NEW MEXICO STATE UNIVERSITY, PROVIDES THE FIRST COMPREHENSIVE VIEW OF PERSONS EFFECTED BY NATURAL DISASTER, HOW WELL THEY RECOVER AND THE ROLE OF PUBLIC AND PRIVATE DISASTER RELIEF AGENCIES IN FACILITATING DISASTER RECOVERY.

- ADDITIONALLY, A SERIES OF CASE STUDIES COMPLETED BY CLAIRE RUBIN AT THE ACADEMY FOR STATE AND LOCAL GOVERNMENT PROVIDES THE FIRST COMPARATIVE PERSPECTIVE OF THE EXPERIENCES OF LOCAL GOVERNMENTS IN BOTH LARGE AND SMALL COMMUNITIES IN RECOVERYING FROM DISASTER. WHILE RUBIN'S WORK FOCUSES ON SUCH DISASTER AGENTS AS FLOODS AND HURRICANES, THE FINDINGS ALSO HAVE IMPLICATIONS FOR HANDLING RECOVERY PROBLEMS FOLLOWING DISASTERS CAUSED BY EARTHQUAKES.

IN 1969 A NAS COMMITTEE, CHAIRED BY DR. GEORGE HOUSNER OF THE CALIFORNIA INSTITUTE OF TECHNOLOGY, CONDUCTED A STUDY "EARTHQUAKE ENGINEERING RESEARCH." THE RESULTING DOCUMENT PROVIDED A COMPLETE EVALUATION OF THE STATUS OF EARTHQUAKE EFFECTS MITIGATION CAPABILITY AT THAT TIME AND MADE RECOMMENDATIONS FOR FUTURE RESEARCH. ANOTHER COMMITTEE, AGAIN CHAIRED BY DR. HOUSNER, HAS JUST COMPLETED A SIMILAR STUDY TO ASSESS THE PROGRESS THAT HAS BEEN MADE, SINCE THE 1969 REPORT. THE NEW TWO VOLUME REPORT IS PRESENTLY BEING DISTRIBUTED. THIS REPORT DOCUMENTS THE TECHNOLOGICAL AND SOCIAL ADVANCEMENTS IN ALL AREAS OF EARTHQUAKE ENGINEERING, IDENTIFIES NEEDED FUTURE RESEARCH, AND

RECOMMENDS APPROPRIATE FUNDING LEVELS TO CONTINUE THE PROGRESS REQUIRED TO MINIMIZE THE IMPACT OF FUTURE EARTHQUAKES.

THE PRESSURES TO CONSTRAIN FEDERAL BUDGETS HAVE MADE MORE IMPORTANT TWO APPROACHES TO GATHERING INFORMATION THAT HAVE BEEN UTILIZED PREVIOUSLY IN A LIMITED WAY. THESE ARE (1) INTERNATIONAL COOPERATIVE RESEARCH PROJECTS, AND (2) ACQUISITION OF DATA FROM EARTHQUAKES AND OTHER NATURAL DISASTERS THAT OCCUR THROUGHOUT THE WORLD. INTERNATIONAL COOPERATIVE EFFORTS WITH COUNTRIES THAT SHARE COMMON SEISMIC PROBLEMS ALLOW THE "POOLING" OF LIMITED RESOURCES TO SOLVE A PARTICULAR PROBLEM. WE HAVE COOPERATIVE RESEARCH VENTURES OF VARYING SIZES WITH THE PEOPLE'S REPUBLIC OF CHINA (PRC), JAPAN, USSR, TAIWAN, INDIA, INDONESIA, ITALY, GREECE, MEXICO, NEW ZEALAND, YUGOSLAVIA, TURKEY, AND PERU. JAPAN AND CHINA ARE OF ESPECIAL INTEREST BECAUSE EACH COUNTRY ALLOCATES ABOUT 3 TO 5 TIMES AS MUCH FUNDING FOR EARTHQUAKE RESEARCH AS THE U.S. DOES.

WE ARE PRESENTLY IN THE SECOND PHASE OF A VERY PRODUCTIVE COOPERATIVE PROJECT WITH THE JAPANESE WHICH INCLUDES THE TESTING OF LARGE-SCALE REINFORCED CONCRETE AND STEEL STRUCTURES IN JAPAN'S UNIQUE TSUKUBA FACILITIES. COMPLETION OF THIS PROJECT WILL PROVIDE VALUABLE DATA ON THE SIZE OF MODELS REQUIRED TO DETERMINE ACCURATELY THE RESPONSE OF BUILDINGS TO SPECIFIC EARTHQUAKE GROUND MOTIONS. WITH FUNDING PROVIDED BY THE AGENCY FOR INTERNATIONAL DEVELOPMENT, WE HAVE ESTABLISHED A JOINT SEMINAR SERIES WITH THE JAPANESE TO ASSIST DEVELOPING NATIONS TO COPE MORE EFFECTIVELY WITH EARTHQUAKE HAZARDS.

A MAJOR EARTHQUAKE ANYWHERE IN THE WORLD PROVIDES A FULL-SCALE EXPERIMENT FROM WHICH MUCH INFORMATION CAN BE OBTAINED ON THE PERFORMANCE OF ENGINEERED STRUCTURES AND THE EFFECTS ON PEOPLE. THIS ACTIVITY INVOLVES THE ACQUISITION OF CRITICAL DATA ON GROUND MOTION AND STRUCTURAL RESPONSE FOR MAJOR EARTHQUAKES IN VARIOUS COUNTRIES. STRONG MOTION INSTRUMENTATION ARRAYS NOW HAVE BEEN ESTABLISHED IN SIX (6) OF THE MOST SEISMICALLY ACTIVE AREAS OF THE WORLD, WHERE THERE IS A HIGH PROBABILITY OF "CAPTURING" AN EARTHQUAKE. SUCH AN ARRAY IN TAIWAN HAS ALREADY RECORDED TWO LARGE EARTHQUAKES, WITH 36 OF THE 37 INSTRUMENTS OPERATING DURING THE MOST RECENT EARTHQUAKE.

INTERNATIONAL ACTIVITIES WILL BE FOCUSED FURTHER WHEN THE U.S. HOSTS THE 8TH WORLD CONFERENCE ON EARTHQUAKE ENGINEERING IN SAN FRANCISCO IN 1984.

A NUMBER OF STUDIES HAVE NOW BEEN COMPLETED ON THE DAMAGING 1979 IMPERIAL VALLEY EARTHQUAKE IN CALIFORNIA. DURING THIS PAST YEAR, REPORTS ON THE DAMAGE CAUSED BY THE EARLIER EARTHQUAKES IN ALGERIA, ITALY AND GREECE ALSO WERE COMPLETED AND DISSEMINATED. THESE RESULTS ARE PRESENTLY BEING STUDIED TO IMPROVE ASEISMIC DESIGN PROCEDURES.

HISTORICAL RECORDS SHOW A LONG HISTORY OF FREQUENT DESTRUCTIVE EARTHQUAKES IN THE BALKAN REGION OF THE WORLD. TO REDUCE THE DEATH AND DESTRUCTION FROM FUTURE EARTHQUAKES IN THE BALKANS A SPECIAL PROGRAM HAS BEEN ESTABLISHED UNDER UN-UNIDO TO ASSEMBLE

THE LATEST KNOWLEDGE GAINED THROUGH RESEARCH INTO A SERIES OF GUIDEBOOKS AND MANUALS WHICH CAN BE USED TO REDUCE RISKS AND IMPROVE THE PERFORMANCE OF NEW AND EXISTING CONSTUCTION SUBJECTED TO EARTHQUAKES. THROUGH THIS ACTIVITY, THE U.S. CAN CONTRIBUTE MUCH INFORMATION AND WILL RECEIVE THE ADVANTAGE OF POSSIBLY HAVING THIS INFORMATION TESTED BY THE MORE FREQUENT BALKAN EARTHQUAKES AND IN LEARNING FROM THE RESEARH AND EXPERIENCE OF THE MOST TALENTED RESEARCHERS IN SIX OTHER COUNTRIES. THE MANUALS WHICH WILL RESULT FROM THE PROGRAM WILL BE MADE AVAILABLE (IN ENGLISH) TO THE TECHNICAL COMMUNITY IN THE U.S. COORDINATION OF THIS PROJECT IS BEING HANDLED BY PROF. TORIDIS OF THE GEORGE WASHINGTON UNIVERSITY.

OTHER NATURAL DISASTERS HAVE COMMON CHARACTERISTICS WITH EARTHQUAKES, FOR EXAMPLE, WINDS, TORNADOES, HURRICANES AND TSUNAMIS MAY PRODUCE DYNAMIC LOADS ON STRUCTURES SIMILAR TO EARTHQUAKE FORCES, AND THEREFORE WE CONTINUE TO UTILIZE SUCH INFORMATION. PUBLIC REACTIONS TO MANY NATURAL DISASTERS HAVE MANY COMMON ELEMENTS AND THUS MUCH CAN BE LEARNED FROM SUCH EVENTS. DURING THE PAST YEAR, TEAMS WERE DISPATCHED TO THE SITE OF THE FLOODS IN (JANUARY 1982) NORTHERN CALIFORNIA AND THE HURRICANE IN HAWAII (NOVEMBER 1982). REPORTS OF THESE DISASTERS AND THEIR IMPACT ON SOCIETY ARE NOW IN PREPARATION.

AS I DISCUSSED EARLIER, WE HAVE HAD A COOPERATIVE RESEARCH PROGRAM WITH THE JAPANESE DURING THE PAST SEVERAL YEARS. THIS HAS UTILIZED THE HIGH QUALITY LARGE EXPERIMENTAL FACILITIES CONSTRUCTED IN JAPAN, AND IN THE SHORT TERM THIS HAS ALLOWED THE U.S. TO MOVE AHEAD IN THE EARTHQUAKE ENGINEERING FIELD.

IN THE PROBLEM-FOCUSED PROGRAM WITHIN THE ENGINEERING DIRECTORATE, FUTURE RESEARCH ACTIVITIES WILL EMPHASIZE THE RESPONSE OF GEOTECHNICAL MATERIALS TO DYNAMIC FORCES, LARGE- AND FULL-SCALE TESTING TO VERIFY AND DEVELOP NEW CONCEPTS, THE INELASTIC BEHAVIOR OF STRUCTURES SUBJECTED TO SEISMIC LOADS, SPECIAL INSTRUMENT ARRAYS IN HIGHLY SEISMIC AREAS OF THE WORLD, THE BEHAVIOR OF "LOW-RISE" STRUCTURES, AND THE INFLUENCE OF ARCHITECTURAL AND URBAN PLANNING ON THE VULNERABILITY OF STRUCTURES AND COMMUNITIES. WE WILL CONTINUE RESEARCH TO DETERMINE THE 3-DIMENSIONAL BEHAVIOR OF ENGINEERING MATERIALS AND STRUCTURES IN AN EARTHQUAKE ENVIRONMENT. WE WILL CONTINUE TO STUDY THE IMPACTS OF EARTHQUAKES ON SOCIAL AND ECONOMIC COMMUNITY SYSTEMS AND DEVELOP PROCEDURES THAT WILL MINIMIZE THESE IMPACTS.

THANK YOU MR. CHAIRMAN FOR ALLOWING ME TO SUMMARIZE THE ACTIVITIES OF THE EARTHQUAKE HAZARD MITIGATION PROGRAM IN THE NATIONAL SCIENCE FOUNDATION. SIGNIFICANT PROGRESS CONTINUES TO BE MADE IN A VARIETY OF SCIENTIFIC, ENGINEERING AND SOCIAL AREAS AND THE RESEARCH EFFORTS THAT WE ARE SUPPORTING ARE DIRECTLY AFFECTING DESIGN AND MITIGATION PROCEDURES IN ALL PARTS OF THE U.S.

I WILL BE HAPPY TO ANSWER ANY QUESTIONS THAT YOU OR MEMBERS OF THE SUBCOMMITEE MAY HAVE.

Mr. **Brown** [acting chairman]. Thank you very much, Dr. Sanderson.

Dr. Wright, you are next.

[The biographical sketch of Dr. Wright follows:]

January 1983

RICHARD N. WRIGHT

Date of Birth: May 17, 1932

Birthplace: Syracuse, New York

Education:

Syracuse University, B.S.
  Civil Engineering, 1953
Syracuse University, M.S.
  Civil Engineering, 1955
University of Illinois, Ph.D.
  Civil Engineering, 1962

Position:

Director, Center for Building Technology
National Engineering Laboratory
National Bureau of Standards

His professional experience includes employment with the Pennsylvania Railroad, 1953 to 1955; Military Service, 1955 to 1957; appointments as instructor, assistant professor, associate professor and professor of civil engineering at the University of Illinois at Urbana from 1957 to 1974; and service with the National Bureau of Standards as Chief of the Structures Section, Building Research Division, Institute for Applied Technology, 1971 to 1972, Deputy Director-Technical, Center for Building Technology, 1972 to 1973, and as Director, Center for Building Technology, 1974 to present.

The Center for Building Technology (CBT) increase the usefulness, safety and economy of buildings by providing: (1) Improved measurement techniques, evaluation methods and technical data to accelerate the use of improved and innovative building practices and materials; (2) Technical bases for building standards, specifications, codes and practices.

CBT has a staff of 160. CBT engineers and scientists conduct field, laboratory, and analytical research on the performance of building materials, components, and systems, and on building practices. Results are used by building owners, designers, contractors, labor, manufacturers, standards organizations, public agencies, testing laboratories, and other research organizations worldwide. Seventy percent of its research is sponsored by other Federal agencies and private sector organizations requiring improved practices for the characterization and measurement of building performance.

Dr. Wright's own research has produced about fifty publications in structural design, methods for earthquakes and other dynamic loads, flow and fracture in structural metals, mechanics of thin-walled beam structures, computer-aided design, formulation and expression of design criteria, reliability and performance criteria for buildings, and building regulatory procedures.

He is a fellow of the American Society of Civil Engineers (Chairman of the Committee on Civil Engineering Productivity and Chairman of the Committee on Standards Procedures), Representative of the U.S. National Research Council to the International Council for Building Research, Studies and Documentation (CIB), member of the Board of CIB, member of the Programme Committee of CIB, Chairman of the Board of the Lighting Research Institute, Chairman of the Interagency Committee on Seismic Safety in Construction, and member of the International Union of Testing and Research Laboratories for Materials and Structures (RILEM), Earthquake Engineering Research Institute, Sigma Xi, Phi Kappa Phi, and Tau Beta Pi. He registered as a professional engineer in New York in 1958 and as a structural engineer in Illinois in 1974.

He received the Gold Medal Award of the Department of Commerce in 1982 for distinguished achievment in the Federal Service.

STATEMENT OF RICHARD WRIGHT, DIRECTOR, CENTER FOR BUILDING TECHNOLOGY, NATIONAL BUREAU OF STANDARDS, ACCOMPANIED BY RAYMOND KAMMER, DEPUTY DIRECTOR, NATIONAL BUREAU OF STANDARDS

Dr. WRIGHT. Thank you, Mr. Chairman.

Raymond Kammer, Deputy Director of the National Bureau of Standards, and I are happy to appear here this afternoon.

With your permission, we will submit our written testimony for the record and I will summarize it.

The role of the National Bureau of Standards in the earthquake hazard reduction program is to perform research on performance criteria and measurement technology for earthquake-resistant construction. This work is conducted in the Center for Building Technology at the Bureau of Standards.

We also provide technical support to private and public organizations in the development and application of seismic design and construction provisions.

Our recent research accomplishments include an assessment of the most widely used soil testing method, the standard penetration test, to make its results more comparable nationwide and internationally.

We have studied the liquefaction of loose, sandy soils under earthquake conditions and reported a threshold strain criterion to more accurately define soil deposits that are susceptible to liquefaction and, therefore, likely to be inadequate as foundations for buildings.

We have developed and commissioned a six dimensional force and displacement controlled apparatus for testing walls and columns under simulated seismic motions. This allows this apparatus to simulate the force and deformation history that a wall would undergo at various positions in a building.

We are initiating, with support from the State of California, Department of Transportation, the National Science Foundation and the Federal Highway Administration, studies of large-scale bridge columns in order to pursue exactly the scale effect that Dr. Sanderson just mentioned.

In the area of technical support for State and local governments, Federal agencies, and the private sector in the development of seismic design and construction practices, we have assisted the private sector Building Seismic Safety Council, in studying the tentative provisions for nationally applicable seismic design criteria. In the past year jointly with the Building Seismic Safety Council we have issued reports on amendments to the provisions to define precisely the provisions to be used in the trial design program, and we have issued a detailed plan under which this trial design program will be conducted.

We serve as the secretariat for the American National Standards Institute Committee on Design Loads for Buildings. The updated version, the first in 10 years, was published this past year. It implements the work that the Geological Survey, the National Science Foundation, and other agencies have done in preparing a better understanding of earthquake risks nationwide and contains this knowledge in earthquake hazard maps to be used for design of structures nationwide. This document also contains other NBS research on such factors as windloads and common load factors that allow structures from different materials to be designed in an economical and consistent fashion.

I chair the Interagency Committee on Seismic Safety and Construction that Mr. Krimm mentioned. We have revised the membership to have 23 agencies represented with policy-level people, and we have reorganized the Interagency Committee to focus on 4 key areas: standards for new and existing buildings, standards for lifelines, site hazards assessment, and dealing with Federal grant, lease and regulatory programs.

Since 1969 we have chaired the U.S. side of the United States-Japan Committee on Wind and Seismic Hazards. As Dr. Sanderson mentioned, very significant progress is being made in cooperative United States-Japanese research under the auspices of this program.

I also serve on the board of the International Council of Building Research. Under the auspices of this council, we have established an international working commission on earthquake hazard reduction. This is chaired by Dr. Butcher of the National Science Foundation.

All of these activities are focused on the effective development and implementation of earthquake hazard reduction measures.

In the fiscal year 1984 budget we have proposed to terminate the NBS earthquake hazard reduction program in concert with the administration's policy to disengage from areas of State and local government and private industry responsibility.

Thank you, Mr. Chairman. I will be happy to respond to any questions.

[The prepard statement of Dr. Richard N. Wright follows:]

U. S. DEPARTMENT OF COMMERCE
STATEMENT OF RICHARD N. WRIGHT, DIRECTOR
CENTER FOR BUILDING TECHNOLOGY
NATIONAL ENGINEERING LABORATORY
NATIONAL BUREAU OF STANDARDS
BEFORE THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
ON THE EARTHQUAKE HAZARD REDUCTION PROGRAM
March 13, 1983

Good afternoon. Raymond Kammer, the Deputy Director of the NBS, and I are here to discuss the earthquake hazard reduction efforts of NBS. These activities are conducted in the Center for Building Technology.

NBS Role in the Earthquake Hazards Reduction Program

The National Earthquake Hazards Reduction Program (NEHRP) resulted from the Earthquake Hazards Reduction Act of 1977 (P.L. 95-124). Under this program NBS conducts research to establish performance criteria and develop measurement technology for earthquake-resistant construction. For example, we developed test methods and procedures for evaluating the potential of soils to liquefy during earthquakes. We also assist and cooperate with other Federal agencies and other organizations such as the National Institute of Building Sciences, professional organizations, model code groups, and state and local building departments, in continuing the development, testing, and improvement of model seismic design and construction provisions. We worked with the Interagency Committee on Seismic Safety in Construction (ICSSC) to develop a uniform Federal standard for seismic design which was published in 1981. We also assisted the Building Seismic Safety Council (BSSC) in developing tentative seismic safety provisions and planning a trial design program to evaluate the provisions.

Fiscal Year 1984 Budget

For fiscal year 1983, NBS as a whole is operating at an annual rate of $117,861,000. The proposed budget for fiscal year 1984 includes an increase for cost of living of $5,908,000 and decreases totaling $25,069,000 and 179 positions for programs supported by direct appropriation. The net reduction from the fiscal year 1983 level is $19,161,000.

The budget for NBS reflects the Administration's policy of supporting basic research, particularly in the areas of physical sciences and engineering. The budget for fundamental measurement sciences related to these areas has remained intact.

In FY 1984 the Center for Building Technology is proposed to be abolished. This is reflected in the FY 1984 NBS budget as a reduction of $3,200,000. Included in this is a reduction of $475,000 for NBS earthquake efforts. The discontinuation of this program is in concert with this Administration's policy of disengaging the Federal Government from areas of State and local government responsibility. The construction industry, in cooperation with State and local building code authorities, can take a more active role in supporting building research. Moreover, the Federal government will maintain a significant presence in seismic design and engineering through the programs of USGS, FEMA, and NSF.

This concludes my formal statement. I will be pleased to answer any questions you may have.

Attachment

NBS Accomplishments in Earthquake Hazards Reduction

Earthquake Investigations

NBS has a long history of involvement in earthquake research activities. Beginning in 1969, we assisted the State Department in establishing a Subpanel on Wind and Seismic Effects of the United States-Japan Panel on Natural Resources. To determine needs for improved seismic design and construction and for research in this area, we investigated large earthquakes in San Fernando, California (1971); Managua, Nicaragua (1972); Romania (1977); Miyagi-ken-oki, Japan (1978) and Imperial County, California (1979). We worked in cooperation with other Federal agencies and the Earthquake Engineering Research Institute in conducting these investigations.

Accomplishments in Research

The earthquake program includes strong laboratory-based research activities that strengthen our contributions and participation in the development of improved design criteria. Our geotechnical engineers are conducting research on improved measurements for site evaluation and improved techniques for evaluation of the potential for soils to liquefy during earthquakes. We have continued work on improving existing techniques for site evaluation. Two proposed standards based on this research are currently being considered for adoption by the American Society for Testing and Materials (ASTM).

We have recently completed the construction of a computer-controlled three-dimensional testing facility for structural research. This unique facility currently is being used in studying the basic energy absorbing mechanisms and strength of masonry shear walls subjected to seismic loading. We are beginning work on large-scale bridge columns which will extend our understanding of the performance of very large scale structures and will provide data that are not currently available. We will examine both full-scale performance at large deformations and the effect of size on test results to determine if research conducted on small-scale specimens can be safely extrapolated to sizes actually used in bridges. This work is being supported by NBS, the Federal Highway Administration, the National Science Foundation (NSF), and the California Transportation Department.

Accomplishments in Seismic Design and Construction Practices

NBS provides technical support to the Federal Emergency Management Agency (FEMA), the lead agency responsible for coordinating the National Earthquake Program. This includes participating on the Interagency Committee on Seismic Safety in Construction and the Building Seismic Safety Council, as well as contributing to the planning of earthquake-related Federal research.

The Interagency Committee on Seismic Safety in Construction (ICSSC) was formed in 1978 by FEMA to develop guidelines for reducing earthquake hazards for use by Federal agencies involved in construction. We have provided technical support to this

Committee since its inception including contribution of the acting chairman from September 1981 to December 1982 and the chairman beginning in December 1982. During this period we reaffirmed the agency membership and streamlined the technical subcommittee structure. The ICSSC met on December 21, 1982 and on March 10, 1983. It is currently reviewing a draft seismic standard for Federal buildings that was developed in 1981 by an ICSSC subcommittee chaired by NBS and is now preparing a similar document for existing buildings. It also is addressing the areas of lifelines, site hazards, and Federal policies for grant, lease, and assistance programs.

NBS, FEMA, and concerned groups of the building community worked together to help establish the Building Seismic Safety Council (BSSC) in April 1979. The objective of the BSSC is to provide a national forum to promote the development of seismic code provisions suitable for use throughout the United States. The Council's first specific task was to review the Tentative Provisions for the Development of Seismic Regulations for Buildings that were developed in an NBS-Applied Technology Council project in the 1970's.

At the request of the BSSC, NBS provided technical support for the review. With financial support from FEMA, we worked with approximately 50 organizations from throughout the United States to review and improve the Tentative Provisions. In 1981, we published 11 reports for the BSSC which provided the basis for proposed refinements to the Tentative Provisions.

The Council is undertaking an evaluation of the amended Tentative Provisions by a phased trial design program that is funded by FEMA. Phase I, which is in progress, includes designs of 26 buildings in four cities. Phase II, which will conclude the trial designs, and Phase III which will include the recommendations of the BSSC for seismic design are being planned now. We are now providing technical support for the BSSC Trial Design Overview Committee. This has included the joint preparation of reports on the amendments of the Tentative Provisions and the plan for the trial designs.

International Activities

Through participation on the Subpanel on Wind and Seismic Effects of the U.S.-Japan Program on Natural Resources, NBS and NSF have encouraged the formulation of a cooperative program on large-scale structural research. With funding from NSF, research is now underway in Japan on steel structures and will begin shortly in the United States. Laboratory work on the seismic resistance of reinforced concrete structures is complete.

I am the U.S. representative to the International Council on Building Research. In this capacity our efforts have led to establishment of an international working commission on earthquake hazard reduction which is chaired by a representative of NSF. We also have a cooperative program with the French national laboratory for building research (Centre Scientifique et Technique du Batiment) which includes a new project on seismic repair and retrofit of existing buildings.

Mr. **Brown**. Thank you very much, Dr. Wright.

Mr. McGrath, would you like to address any questions to the witnesses?

Mr. **McGrath**. Yes, just to Dr. Wright.

The Center for Building Technology seems to be the only one that is being zeroed. What plans do you have for transferring some of the information that we understand has already been established in that program to other agencies or other areas?

Dr. **Wright**. The Center for Building Technology is not the only National Bureau of Standards Center being terminated in the fiscal year 1984 budget proposal, but it is the one that is directly in the earthquake hazard reduction program.

We publish our results as soon as they are achieved and the material is properly reviewed, so that we plan to terminate our ongoing work in an orderly fashion to make the results available to the public and to end the program.

Mr. **McGrath**. Thank you.

Mr. **Brown**. Mr. Skeen.

Mr. **Skeen**. I have no questions, Mr. Chairman.

Mr. **Brown**. Dr. Sanderson, I was intrigued by your description of the research being done on insulating buildings from the effects of earthquakes using a rubber pad or some elastic——

Dr. **Sanderson**. Rubberlike material.

Mr. **Brown** [continuing]. Rubberlike material. The past practice has been to use rollers or something like that, hasn't it?

Dr. **Sanderson**. In general in this country we have not attempted aseismic construction that used isolation techniques. The general practice has been simply to strengthen the building to withstand the shaking, so that the building absorbed the forces. There has been some construction in New Zealand and other countries using isolation techniques.

Roller techniques are used in construction, not so much for seismic isolation, but to allow for thermal expansion where one has to cope with the differential expansion between the structure and the framework on which it is constructed. You see a very good example of that when you drive down the highway and cross a bridge. You will notice such construction where the bridge is free to move with respect to the supporting abutments without cracking and stressing the bridge.

The use of decoupling techniques in construction is well proven but it has not been used for application to such high-frequency motions as an earthquake.

Mr. **Brown**. Each of your agencies I guess is suffering some budget restrictions on the program. Yours, Dr. Wright, seems to be the worst. You are being terminated with prejudice, as they say. [Laughter.]

Dr. Peck, you are suffering about a $5 million reduction in the program.

Dr. Sanderson, what is the situation?

Dr. **Sanderson**. The Earthquake Hazards Program in NSF in the basic Earth sciences is growing at slightly over 10 percent this year. In the earthquake engineering area it is growing at about 9 percent. That follows several years of essentially flat budgets, but we are planning budget growth this year.

Mr. **Brown**. I recall now, you are getting extra good treatment in your agency this year.

Dr. **Sanderson**. We have been very fortunate this year, sir.

Mr. **Brown**. Very fortunate. I think it has something to do with something else.

What is the budgetary situation on the earthquake program, Mr. Krimm, from your standpoint?

Mr. **Krimm**. It is about the same as it was last year, which is 4.3.

Mr. **Brown**. You, Dr. Peck, described in some detail the effect of this reduction, which amounts to about a 15-percent reduction or so. That is going to require you to lower your personnel by attrition and to eliminate some of the fieldwork and some other things.

Dr. **Peck**. Yes. Actually, the budget cut is about a $6 million program cut. It is kind of complicated because all of the programs are up a little bit because of the pay raise and because of the standard level user charge.

However, actually the program was increased $4 million in fiscal year 1983 by congressional action and by the transfer of some functions from the National Science Foundation. Anticipating that constrained budgets might follow, over 50 percent of those funds has been used for things like implanting volumetric strain meters in drill holes along the San Andrea Fault, in buying an additional two-color laser geodemeter in order to install it in southern California to measure displacement, and in some design studies of an operational earthquake network in southern California.

Some of it is an investment in the future that if the funds are not there next year, we were not going to spend them for that anyway. Therefore, the cutback in the operating funds is not so dramatic.

Mr. **Brown**. Last year I recall there was some problem about getting enough funds for the extension of the monitoring network that you were trying to establish in—was it southern California or some part of California?

Dr. **Peck**. I must confess I forget.

Mr. **Brown**. It is not all that important.

I was glancing at the National Research Council report entitled, "Earthquake Engineering Research, 1982," just before I came in here, and I want to read a sentence out of it to you to see how it grabs all of you.

It says here that, "The present U.S. effort in earthquake hazard reduction is inadequate to solve the earthquake problem in the foreseeable future."

That was before you had your budget cuts. I recognize that this was put together by people who are not operating under Federal budget, but would you generally concur in that analysis made by that highly prestigious group.

Dr. **Peck**. We are still making a major effort. It is a $30 million program, and we are working very closely with the university community, supported by the National Science Foundation, with Taiwan, the Soviet Union, Japan, and China so that scientific findings about earthquake predictions are exchanged all around the world. That is still a sizable effort directed at the problem, but it is a formidable problem. It is a little analogous to finding a cure for cancer.

Mr. **Brown**. We are not putting nearly as much money into earthquakes as we are into cancer.

Dr. **Peck**. It doesn't kill as many people, either.

Mr. **Brown**. Are you familiar, Dr. Wright, with that building down in Imperial County in California which was designed to be earthquake resistant and which was essentially destroyed in the last earthquake down there?

Dr. **Wright**. I am generally familiar with it. One of our staff members was part of the Earthquake Engineering Research Institute team that did the investigation following the earthquake.

Mr. **Brown**. What did we learn from that episode?

Dr. **Wright**. It was a well-instrumented earthquake and a well-instrumented building, and I believe the National Science Foundation has sponsored some very detailed studies of it. It should substantially improve our understanding of how buildings behave when loaded right up to the point of failure.

Of course, that building was a success by the criteria under which it was designed. It was designed not to collapse in an earthquake, and it did not collapse. Therefore, it is a very good experiment in the sense that we got severe structural damage and we got it under well-instrumented conditions, so it can do a great deal to confirm our laboratory and analytical understandings of how much a building can take.

Mr. **Brown**. Was there something unusual about the earth motion there that produced the damage to the columns?

Dr. **Wright**. Not to my knowledge.

Mr. **Brown**. Are you familiar with that situation, Dr. Sanderson?

Dr. **Sanderson**. In the same general terms perhaps that Dr. Wright is. I am not aware of any unusual characteristics of the ground motion at that point other than the presence of a stronger vertical component than was generally expected for this area.

One of the questions which I asked my staff was, given the decade or so of progress since the time that building was built, would we have built it that way today? The response I got back was that, although it was built based on the best knowledge we had available at the time, current design practice would not have resulted in as much damage as occurred to the building.

Mr. **Brown**. We are talking about a building that is only about 10 years old or something like that.

Dr. **Sanderson**. That is correct.

Mr. **Brown**. We are in a rapidly evolving situation. Is that being reflected in changes in the various codes and other guidance to the design and construction industry?

Dr. **Sanderson**. I think it is being reflected in changes in the codes. That takes some time. There has been an effort to develop model codes in this area for implementation by State and local groups responsible for building codes. As I am sure you are aware, that sort of process proceeds slowly on a jurisdiction-by-jurisdiction basis.

At the same time I think it is being rapidly introduced into the engineering and the architectural community, particularly in the west coast areas where there is a high sensitivity to this.

We are sponsoring a number of workshops to introduce it. Many of the high rise buildings, particularly the buildings which are now being constructed, contain structural design requirements that have developed out of new facts that have been developed within the last decade.

Dr. **Peck**. Let me interject, Mr. Chairman. We have recently published a volume entitled, "The Imperial Valley Earthquake of October 15, 1979," containing a variety of studies of that earthquake.

Mr. **Brown**. You just happen to have one with you?

Dr. **Peck**. Yes. I am glad you asked that question. It includes the strong motion data.

Mr. **Brown**. Would you be able to allow the subcommittee to have that?

Dr. **Peck**. I would be pleased, Mr. Chairman.

Mr. **Brown**. The subcommittee will receive those very valuable reports for its records.

Dr. **Peck**. From the very good, strong motion data we got, we were able to derive a formula so that we can calculate what the strong motion should be in other areas. It is very valuable data.

Mr. **Brown**. Very good.

Dr. **Sanderson**. Mr. Brown, not realizing that you would be chairing the meeting, we brought along a similar report prepared——

Dr. **Peck**. They blew it.

Dr. **Sanderson** [continuing]. Prepared particularly for the Eastern United States. [Laughter.]

Mr. **Brown**. Well, despite the lesser importance of that report——[Laughter.]

Mr. **Brown** [continuing]. We will also receive that for the subcommittee records.

Mr. **Skeen**. Do you have one for the Southwest?

Mr. **Brown**. Generally speaking, gentlemen, my reaction to the progress of research in this area has been favorable. I think you are doing an estimable job under the resource constraints that you have. Obviously, I am not satisfied with those constraints, but I am pleased that the work is continuing and is having valuable results.

I am not quite so sure, Mr. Krimm, that I am happy with the overall coordination from the disaster standpoint. I say I am not sure because I do not know enough about this situation. Generally speaking, it has been my impression that your agency was not seizing on this opportunity for all that I perceived that it might be worth.

There is a great deal that can be learned and there is a great deal that can be put into practice in anticipation of earthquakes that has general value for the mitigation of any kind of hazard. The development of the capability to respond on an integrated basis, it seems to me, was where perhaps your agency was weak.

Without having before me the detailed information that would allow me to criticize what you are doing, would you just elaborate a little on the comment you made about what you are doing in this area to reassure me that you are doing everything possible.

Mr. **Krimm**. During the past year the ICC subcommittee met under FEMA's chairmanship and developed a planning guidance for catastrophic earthquakes. The planning guides were published in the Federal Register, March 4, 1983. This Federal Register notice included a schedule for plan development and exercises with a full exercise scheduled in June 1985 to test the ability of the Federal Government to respond to a catastrophic earthquake in California.

We have been moving along in that area. I believe that the Government is much better prepared than what it was last year at this time.

Mr. **Brown**. I am glad to hear that.

Mr. **Krimm**. We will be very glad to send you a copy of the Federal Register notice when it comes out.

Mr. **Brown**. Would you do that, please?

Mr. **Krimm**. Yes.

Mr. **Brown**. I would appreciate it very much.

I might want to spend a little time in the agency getting a little more detail on some of the work that you are doing there, if I might.

Mr. **Krimm**. We would be delighted to have you come down.

Mr. **Brown**. Mr. Boehlert, do you have any questions?

Mr. **Boehlert**. No questions, Mr. Chairman.

Mr. **Brown**. Would you like to ask some questions?

Mrs. **Brown**. No, thank you.

Mr. **Brown**. Thank you very much, gentlemen. We are going to be very easy on you because we have a number of other witnesses today. We appreciate your cooperation.

Our next witness is Mr. Lowell Dodge, Associate Director, Resources, Community, and Economic Development Division, General Accounting Office.

While Mr. Dodge is coming to the table, I would like to indicate that, without objection, any other members who desire to include an opening statement at the beginning of the hearing may do so.

You may introduce your colleagues, Mr. Dodge, and proceed with your testimony.

[The biographical sketch of Mr. Dodge follows:]

LOWELL DODGE

Associate Director

Resources, Community and Economic Development Division

U.S. General Accounting Office

Lowell Dodge became an Associate Director in GAO in May 1981. He is responsible for managing GAO reviews at a number of Federal agencies, including FEMA, FCC, SBA, CFTC, NBS, and the Farmers Home Administration.

At GAO Mr. Dodge has overseen a range of reviews on disaster assistance, flood insurance, and readiness for natural disasters.

Prior to May 1981, Mr. Dodge was the chief assistant to the Chairman at the Consumer Product Safety Commission. From 1975-1978, Mr. Dodge served as special counsel and Task Force Director on the staff of the House Commerce Subcommittee on Oversight and Investigations, chaired by Representative John Moss.

Mr. Dodge was Editor-in-Chief of the Environmental Law Reporter from 1974-1975. He ran the Center for Auto Safety, a public interest group in Washington, from 1969-1974.

Mr. Dodge holds a J.D. from Harvard Law School and a BA from Yale University.

STATEMENT OF LOWELL DODGE, ASSOCIATE DIRECTOR, RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION, GENERAL ACCOUNTING OFFICE, ACCOMPANIED BY RONALD WOOD, GROUP DIRECTOR; AND LOUIS SCHUSTER, EVALUATOR

Mr. DODGE. Thank you, Mr. Brown.

To my left is Ron Wood, group director in charge of our FEMA disaster assistance reviews, and to my right is Mr. Louis Schuster, who captained this particular GAO review.

We welcome your invitation, Mr. Brown and members of the subcommittee, to discuss our review of progress in implementing the Earthquake Hazards Reduction Act of 1977, as amended.

This review is aimed primarily at assessing how well FEMA is carrying out its lead role under the act.

In summary, Mr. Chairman, our draft report indicates that despite some progress since mid-1981, implementation of the act has fallen behind schedule. FEMA has not carried out several provisions of the act and has missed deadlines on others. We believe FEMA should, nonetheless, remain the lead agency because of its primary disaster assistance role in the event of a major quake.

In furtherance of the act's objectives, FEMA would be well advised, we believe, to put in place an interagency mechanism for planning, budgeting, and evaluation for the purpose of guiding Federal agencies participating in the program.

My prepared testimony for today addresses four major areas: the principal requirements of the act, as amended; FEMA's progress in implementing these requirements; factors which may have limited FEMA from fully complying with the act; and the status of earthquake prediction efforts. With your permission, I will summarize our points on these subjects here today.

The 1977 act sought to establish an integrated national earthquake hazards reduction program under which Federal, State, and local governments and private organizations would jointly plan and coordinate efforts to reduce earthquake hazards.

Then after FEMA began operations in 1979, Congress amended the act designating FEMA as the agency with primary responsibilities to plan and coordinate the earthquake program.

Then in 1982 the President issued an Executive order delegating to FEMA the functions assigned to the President under the 1977, act as amended. This order makes FEMA responsible for performing important functions itself rather than recommending them to the President for him to execute.

It is worth revisiting for a moment the 1977 act, as amended, and the 1982 Executive order, which, taken together, require FEMA to assign roles and responsibilities to each appropriate agency as a part of the earthquake program; to establish goals, priorities, budgets, and target dates for the implementation of the program; to compile a written, multiyear program plan to have been completed by September 30, 1981, and to transmit that plan to the Congress and to update it annually; to submit an annual report to the Congress within 90 days after the end of each fiscal year evaluating the progress achieved during the preceding year in reducing earthquake risks, a report that was to include a copy of the multiyear program plan; finally, to provide for qualified and sufficient staffing for the program.

These requirements amount to a charge to FEMA to establish an integrated management system for the earthquake program, including staffing, the development of priorities and budgets, and the performance of program evaluations.

How well has FEMA performed these requirements? FEMA officials view their lead agency role as evolving over time. Initially, FEMA defined its role narrowly, functioning as a coordinator rather than as a leader or a manager. It has generally left management decisions associated with planning, budgeting, and evaluation to each agency to determine for its own earthquake activities.

Since mid-1981, FEMA has stepped up the pace of earthquake program activities. FEMA's program officials told us they plan to assume a more aggressive role in the near future.

FEMA's limitation of its lead role to that of coordinator has affected its performance of the requirements assigned to it under the act. Prior to the 1982 Executive order, FEMA had not made recommendations to the President concerning the roles and responsibilities of the various agencies, nor had it made recommendations with regard to the goals, priorities, budgets, and target dates for implementing the program, as mandated under the act.

Following the Executive order, when FEMA was itself to have assigned these roles and set the goals, priorities, and target dates, it has not done so.

FEMA has also not completed work on the multiyear program plan. This plan, on which FEMA places great emphasis, should have been transmitted to the Congress by September 30, 1981, and updated annually. Now, 17 months after that date, the plan is still in draft form and is yet to be issued.

FEMA has created an independent panel of experts to review the draft. This panel is still at work.

We have reviewed the September 1982 version of the draft, the most current one available to us. That plan lacks elements that are essential to a complete program plan, including a detailed delineation of goals, priorities, timetables, and a consolidated program budget.

As of March 1, 1983, FEMA had produced only one annual report since 1979, the year the President delegated this task to FEMA, although we understand that FEMA submitted its 1982 report yesterday to congressional committees.

FEMA has not provided for qualified and sufficient staffing for the program.

In 1981, FEMA did begin taking steps toward implementing the national earthquake hazards reduction program. It established a group late in 1981 called the Interagency Coordination Committee. As our full statement points out, however, this committee does not function as a mechanism for achieving an integrated national earthquake program.

More recently, FEMA established a high-level policy group intended to take actions to meet the requirements of the act for establishing goals, priorities, budgets, and target dates for an integrated national earthquake program. This group, which is chaired by FEMA at the level of the Associate Director of the agency, has met several times to date. It is too early, however, to tell whether this group will meet the agency's expectation that it become the operative interagency mechanism of the earthquake program.

Our review did identify a number of factors which may have affected FEMA's progress in implementing the program.

The first is a belief expressed by FEMA program officials that FEMA lacks sufficient statutory authority to implement the assigned lead agency responsibilities, such as initiating an interagency budget process.

Other factors that may have affected FEMA's progress are listed in our statement, and I will not detail them orally. Let me address, however, for a moment the question of FEMA's authority.

The assertion that FEMA may lack sufficient authority to carry out its lead role in the earthquake program is one we heard only from program officials in FEMA. Their doubts focused on the issue of whether FEMA can control, direct, or otherwise influence the actions of other agencies. On this question, we would observe that granting FEMA more control than it already is authorized to exert over the actions of other agencies may not be essential to a viable earthquake hazards reduction program.

We found many models for interagency cooperative arrangements, several of which extend to joint agreements on budgets and priorities. These arrangements can work without granting any one agency the power to control the decisions of another. A good example is the interagency program addressing the acid rain problem which has implemented a consolidated budget process.

In short, FEMA has not been as resourceful as it might have been in using its existing authority to shape an interagency management system.

I turn, finally, to the question of lack of action on an earthquake prediction system. The question of how much priority to assign to the development of an earthquake prediction system is one which FEMA and other agencies, including the U.S. Geological Survey, might usefully address jointly in the course of interagency deliberations. The expectation in 1977, when the act was passed, that development of an earthquake prediction system could be completed and a prototype put in place has not materialized. Previous witnesses have addressed the reasons why.

Let me point out that the issues of whether the effort to develop an operational prediction system should be pushed harder and whether its funding should be increased remain essentially unresolved. We believe these issues might benefit, as suggested above, from being subjected to a broader interagency review such as one that FEMA, as lead agency, might initiate.

FEMA has taken initial steps, including the establishment of its high-level interagency policy group, toward more fully developing its lead agency role under the program. We believe FEMA could strengthen its lead role substantially simply by executing more diligently the requirements of the act, including taking an active role in assigning specific responsibilities to other agencies and taking the initiative on joint interagency consideration of priorities, budgets, and target dates for the program.

We believe FEMA can exercise the authority granted to it under the act and under the 1982 Executive order to establish an operative interagency structure. This structure should facilitiate agency agreement on priorities and resolve program issues.

Given the results of our review, we believe that continued interest in oversight by this subcommittee and others could provide important encouragement to FEMA and accelerate the agency's efforts to establish a more viable program.

Mr. Chairman, that concludes my prepared remarks. We would be happy to address any questions that you might have.

[The prepared statement of Lowell Dodge follows:]

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Statement of Lowell Dodge
Associate Director
Resources, Community and Economic
Development Division
Before the
Subcommittee on Science, Research and Technology
of the Committee on Science and Technology
House of Representatives
on
FEMA's Implementation of the Earthquake Hazards
Reduction Act of 1977, as Amended

Mr. Chairman and Members of the Subcommittee:

We welcome your invitation to discuss our review of progress in implementing the Earthquake Hazards Reduction Act of 1977, as amended. This review was aimed primarily at assessing how well the Federal Emergency Management Agency (FEMA) is carrying out its lead role under this act.

A draft of our report is now with FEMA and other affected agencies for their review and comment and is subject to revision based on the comments we receive. My statement today will highlight the findings contained in the draft report and offer our views on ways to improve the implementation of this act.

In summary, Mr. Chairman, our draft report indicates that despite some progress since mid-1981, implementation of the act has fallen behind schedule. FEMA has not carried out several provisions and has missed deadlines on others. We believe FEMA should nonetheless remain lead agency because of its primary disaster assistance role in the event of a major earthquake. In furtherance of the act's objectives, FEMA would be well advised to put in place an interagency mechanism for planning, budgeting, and evaluation, to guide Federal agencies participating in the program.

My testimony today will address the principal requirements of the 1977 act, as amended; FEMA's progress in implementing these requirements; factors which have limited FEMA from fully complying with the act; and the status of earthquake prediction efforts.

THE NATIONAL EARTHQUAKE HAZARDS REDUCTION ACT OF 1977 AND THE EXECUTIVE ORDER OF SEPTEMBER 1982

The 1977 act sought to establish a National Earthquake Hazards Reduction Program, under which Federal, State, and local governments and private organizations would jointly plan and coordinate efforts to reduce earthquake hazards.

The act assigned to the President the development of a plan for implementing the new earthquake program. This plan, presented to the Congress in 1978, set forth principles to guide the program and proposed in general terms the roles various Federal agencies would play. The major agencies involved were the U.S. Geological Survey, the National Science Foundation, and the National Bureau of Standards. The plan did not specify or recommend any particular organizational structure or management system for the program. It did state that a lead agency should be designated to provide "a central focus" for coordinating the program and listed certain functions for the lead agency to perform.

After FEMA began operations in 1979, the Congress amended the act, designating FEMA as "the agency with primary responsibilities to plan and coordinate the National Earthquake Hazards Reduction Program." The Congress stopped short of mandating that FEMA "conduct" the program, as initially proposed in the 1980 House bill. Instead, FEMA was to offer a set of recommendations to the the President. The President was then to assign roles to the appropriate agencies and to set goals, priorities, budgets, and target dates for the program.

In 1982, the President issued an Executive Order delegating to FEMA the functions assigned to the President under the 1977 act, as amended. This order makes FEMA responsible for performing important functions itself, rather than recommending them to the President for him to execute.

The 1977 act, as amended, and the 1982 Executive Order taken together require FEMA to

--assign roles and responsibilities to each appropriate agency as a part of the earthquake program (delegated by the Executive Order);

- --establish goals, priorities, budgets, and target dates for the implementation of the program (delegated by the Executive Order);
- --compile a written multi-year program plan to have been completed by September 30, 1981, transmit it to the Congress, and update it annually;
- --submit an annual report to the Congress within 90 days after the end of each fiscal year that evaluates the progress achieved during the preceding year in reducing earthquake risks, and that includes a copy of the multi-year program plan (delegated by the Executive Order); and
- --provide for qualified and sufficient staffing for the program.

These requirements amount to a charge to FEMA to establish an integrated management system for the earthquake program, including staffing, the development of priorities and budgets, and the performance of program evaluations.

HOW WELL HAS FEMA PERFORMED THESE REQUIREMENTS?

FEMA program officials view their lead agency role as evolving over time. Initially, FEMA defined its role narrowly, functioning as a coordinator rather than as a leader or a manager. It has generally left management decisions associated with planning, budgeting, and evaluation to each agency to determine for its own earthquake activities. Since mid-1981, FEMA has stepped up the pace of earthquake program activities. FEMA's program officials would now like to assume a more aggressive role, but believe they may not have sufficient authority.

FEMA's limitation of its lead role to that of coordinator has affected its performance of the requirements assigned to it under the act. Prior to the 1982 Executive Order, FEMA had not made recommendations to the President concerning the roles and responsibilities of the various agencies or the "goals, priorities, budgets, and target dates for implementation of the program," as mandated by the act. Following the Executive Order, FEMA was itself to assign these roles and set the goals, priorities, budgets, and target dates for the implementation of the program. To date, FEMA has not done so.

FEMA also has not completed work on a multi-year program plan. This plan should have been transmitted to the Congress by September 30, 1981, and updated annually. Now, 17 months after that date, the plan is in draft form and has yet to be issued. FEMA has created an independent panel of experts to review the draft; this panel is still at work. We reviewed the September 1982 draft--the most current available to us. We believe that the plan lacks elements that are essential to a complete program plan, including a delineation of goals, priorities, timetables, and a consolidated program budget.

FEMA has produced one annual report since 1979, the year the President delegated this task to FEMA. The report, which covers fiscal year 1981, consists largely of descriptions of the activities of the U.S. Geological Survey, the National Science

Foundation, the National Bureau of Standards, and other agencies. It does not include an evaluation of progress being made in implementing the earthquake program, as specified in the law. Nor does it include a copy of the multi-year program plan, as required, since FEMA has not issued that plan. FEMA officials state that they are now completing work on the annual report covering fiscal year 1982, which was due to the Congress by December 31, 1982.

FEMA has not provided qualified and sufficient staffing for the program. We found that only one FEMA staff member spends a substantial amount of his time on FEMA's lead role responsibilities under the act. This person is a staff assistant reporting to an official who is three organizational levels below the Director of FEMA. The three officials in line above this assistant each spend smaller portions of their time on the earthquake program, which competes for their attention with numerous other functions for which they are also responsible. Ten or so employees in other parts of FEMA are also engaged in earthquake-related activities, such as assisting State and local governments, but they are not a part of the effort to establish and lead an interagency program.

In 1981 FEMA began taking steps towards implementing the National Earthquake Hazards Reduction Program. It established a group in late 1981 called the Interagency Coordination Committee of the National Earthquake Hazards Reduction Program. This committee was described in the 1981 Annual Report as the program's "formal coordinating mechanism." The committee is composed of mid-level representatives of the major agencies concerned with earthquake hazards reduction and has met on a quarterly basis. Its charter limits its functions to coordinating the activities of participants, and also advising FEMA.

Our review of this committee's efforts indicates that the committee has not addressed the establishment of the "goals, priorities, budgets and target dates" for the implementation of the National Earthquake Hazards Reduction Program. It is accurately described in the program's 1981 annual report as an institutionalization of _ad hoc_ but longstanding, informal relationships among various concerned officials. In short, this committee does not function as a mechanism for achieving an integrated national earthquake program.

More recently FEMA established a high level "policy group" intended to take actions to meet the Earthquake Hazards Reduction Act's requirement for the establishment of goals, priorities, budgets, and target dates for an integrated national earthquake program. This group, which is chaired by FEMA, at the level of Associate Director of the agency, has met several times to date. It is too early to tell whether this group will meet FEMA's expectation that it become the operative interagency mechanism of the earthquake program.

FACTORS AFFECTING FEMA's PERFORMANCE

Our review identified a number of factors that may have affected FEMA's progress in implementing the program. The first is a belief, expressed by FEMA program officials, that FEMA lacks sufficient statutory authority to implement assigned lead agency responsibilities, such as initiating an interagency budget process. I will return to this concern later.

Three other factors that may have affected progress include:

--delays caused by "start-up" problems FEMA has experienced as a relatively new agency,

--FEMA's lack of technical in-house expertise, and

--the view, held by some in FEMA and elsewhere that the existence of numerous channels of informal communication within the "earthquake community" makes it unnecessary to dedicate staff or an office to manage the earthquake program.

With respect to start-up problems, FEMA has existed for nearly four years and can no longer be considered a newborn agency. Concerning staff expertise, FEMA has not taken sufficient advantage of existing opportunities for obtaining expert assistance, including requesting other agencies to detail needed staff, or establishing a standing technical committee. With regard to reliance on informal communications, FEMA recently has acknowledged that dedicating a staff and an office to the earthquake program may have merit.

FEMA's RESPONSIBILITY FOR THE PARTICIPATION OF OTHER AGENCIES IN THE PROGRAM

Our review indicates that FEMA, rather than any other agency, should serve in the lead agency role in the earthquake program. In this regard, FEMA has primary responsibility to take action, if called upon to do so by the President, in the event of a major quake. Such a responsibility, in our view, logically leads to retaining FEMA as the general focal point of earthquake preparedness activities.

The assertion that FEMA may lack sufficient authority to carry out its lead role in the earthquake program is one we heard only from program officials in FEMA. Their doubts focused on the issue of whether FEMA can control, direct, or otherwise influence the actions of other agencies. On this question, we would observe, however, that granting FEMA more control than it is already authorized to exert over the actions of other agencies may not be essential to a viable earthquake hazards reduction program. We found many models for interagency cooperative arrangements, several of which extend to joint agreement on budgets and priorities. These arrangements can work without granting any one agency the power to control the decisions of another. A good example is the interagency program addressing the acid rain problem, which has implemented a consolidated budget process.

As the lead agency, FEMA has not been resourceful in using its existing authority to shape an interagency management system or structure in which other agencies might participate willingly, even on questions related to budgets and priorities. FEMA's day-to-day effectiveness could rest on exercising its responsibility under the act to monitor the progress of other agencies' activities, in connection with preparing the annual report for the program, and on its leadership in the joint effort to produce and update the statutorily required multi-year program plan.

LACK OF ACTION ON AN EARTHQUAKE PREDICTION SYSTEM

The question of how much priority to assign to the development of an earthquake prediction system is one which FEMA and other agencies, including the U.S. Geological Survey, might usefully address jointly in the course of interagency deliberations. The expectation in 1977, when the act was passed, that development of an earthquake prediction system could be completed, and a prototype put in place, has not materialized. Current monitoring systems in California may produce warnings, but not accurate predictions. To upgrade these monitoring systems to prediction systems would involve the application of complex measurement technology and computer modeling. An investment estimated at $60 to $100 million or more for an earthquake hazard zone would be required. Considerable uncertainty exists about the prospects for a reliable operational prediction system even if large sums are invested.

The view is held by some scientists that current funds would be better spent on basic research to increase knowledge of earthquake phenomena, improve our ability to measure them, and develop better ways of evaluating the data collected. However, because the probability of earthquakes in some areas is relatively high, and potential losses large, planning by the U.S. Geological Survey for a prototype prediction system continues.

The issues of whether the effort to develop an operational prediction system should be pushed harder and whether its funding should be increased remain unresolved. These issues might benefit, as suggested above, from being subjected to a broader, interagency review, such as one that FEMA as lead agency might initiate.

THE NEED FOR IMPROVED IMPLEMENTATION OF THE ACT

FEMA has taken initial steps, including the establishment of a high level interagency policy group, toward more fully developing its lead agency role in the National Earthquake Hazards Reduction Program. We believe FEMA could strengthen its lead role substantially simply by executing more diligently the requirements of the act, including taking an active role in assigning specific responsibilities to other agencies, and taking the initiative on joint interagency consideration of priorities, budgets, and target dates for the program.

We believe FEMA can exercise the authority granted to it under the act and the 1982 Executive Order to establish an operative interagency structure. This structure should facilitate agency agreement on priorities and resolve program issues.

Given the results of our review, we believe that continued interest in oversight by this subcommittee and others could provide important encouragement to FEMA, and accelerate the agency's efforts to establish a more viable National Earthquake Hazards Reduction Program.

Mr. Chairman, that concludes my prepared statement. I would be happy to address any questions the subcommittee might have. Thank you.

Mr. Brown. Thank you.

We appreciate your optimistic assessment of the role this committee might play.

Do you have any questions?

Mr. Boehlert. I have no questions, Mr. Chairman.

Mr. Brown. You point out several areas in which you feel FEMA has not fully lived up to the mandate of the 1977 act, and yet you have a few optimistic words to say about the progress that they are making.

Could you speculate as to whether this progress is likely to continue and if we may expect, over time, more of the mandate of the 1977 act is likely to be fulfilled, or do you see this as a variable situation which may or may not happen?

Mr. Dodge. Based on the interviews that we conducted as a part of our review, we do have the sense, Mr. Brown, that FEMA does now seem to be taking seriously its lead agency responsibilities under the act. We do look favorably upon establishment of this high-level interagency policy group as a very real step toward the establishment of an interagency mechanism as distinct from those activities which FEMA conducts as a part of its own earthquake work.

They assure us that they mean business with this policy group, that they intend for it to continue. They are considering formalizing its activities. We think this policy group is one very significant step, but it is not the only one.

We look forward to the release of the 5-year program plan. We would hope that it shows the kinds of improvements that we are told to expect in it when it is released. Those two elements in combination we think give reason to expect that this upward trend in progress by FEMA should continue.

Mr. Brown. You have mentioned that the 5-year plan is in draft form and that you reviewed a draft of it last fall. I think I have a copy of the 1982 fiscal year report here. You mentioned that you had seen the 1981 report. So they are moving ahead.

I am a little disturbed at your description of the level of staffing. Have you seen any subsequent improvement in terms of adequate coordinating staff?

Mr. Dodge. We have had, as you can imagine, a number of conversations with FEMA program officials about the level of staffing of the interagency part of their earthquake activities, the earthquake hazards reduction program part of their activities. They indicate to us that they are considering but have not yet finally decided to dedicate staff to the interagency earthquake program effort.

We have yet to see any clear indication that they do plan to dedicate this staff. We think dedicating staff to lead agency functions is perhaps the single most important step that they could take to make sure that the program as an integrated interagency effort takes on some real life.

Mr. Brown. Perhaps that would be an area that the subcommittee could followup on and encourage them to think about those things.

With regard to the prediction effort, I think it is clear that prediction efforts, based upon the current state of knowledge, are not likely to be as precise as we might like them to be. My question is, does the reduction in the level of resources devoted to acquiring the basic understanding of the earthquake phenomenon, as reflected in the work of the Geological Survey and the National Science Foundation—is that likely to impede even further the development of a prediction network or a prediction capability?

Mr. DODGE. The current system of monitoring, as we understand it, is just that—a system to take readings. In order to make the jump from a monitoring system to one which might generate predictions would require magnitudes of dollar investment far beyond any that we are seeing at the moment.

Mr. BROWN. Could you comment on the nature of the research necessary to complement what is going on, in order to improve the prediction capability?

Mr. DODGE. As I understand it, it has to do not only with the sophistication of the measuring devices that are used to make measurements across the dividing line between plates, but also it has a lot to do with how you transmit data back from these measuring points to the places where the data is then analyzed. Right now we have so-called soft systems, and we need what are termed by some "robust" systems, systems that will not be destroyed in the event of a major earthquake or in the earlier precursor activities before an earthquake. Both of those elements—the sophistication of the measuring devices and the transmission of the data—plus the sophistication of the level of analysis that you can give to the data once you receive it at your central point—are all very expensive undertakings.

You can then compare that investment to the amount of money that might be saved, however, if you did have a prediction system in place, in terms of the preparations that you might make in the event of a warning to reduce economic losses and the loss of life and injury. Based on this comparison, you might reach the conclusion that it is worth the undertaking. We have not seen that kind of calculation taking place yet.

Mr. BROWN. I recognize that this does not fall within the scope of your analysis, nor really within the scope of FEMA's responsibility—that is, the basic research element of this program—but, nevertheless, if I am correct—it is FEMA's responsibility to provide guidance as to the balance and nature of the entire program; is that correct?

Mr. DODGE. That is correct.

Mr. BROWN. Therefore, if there were gaps in one element as compared with another, there should be recognition of that within the FEMA organization?

Mr. DODGE. Yes, although not with the expectation that FEMA would necessarily, on its own, then respond and on its own seek to correct the situation, but that it then might raise the issue within the context of this interagency group and make sure that the issue is addressed by the appropriate agency and dealt with and resolved in an interagency context.

Mr. BROWN. I have been impressed by past recitations of the fact that some of our less-developed countries, such as China, have apparently attempted to do earthquake prediction exercises, not always successfully but in a few cases with remarkable success.

Do you have sufficient information to indicate the reasons why they might be engaging in a prediction exercise in their backward state of knowledge which we are not able to replicate?

Mr. Dodge. I am not certain that we do, but let me ask Mr. Wood or Mr. Schuster whether they might have anything to offer in response to that.

Mr. Schuster. Sir, I think one factor in some of these other countries is that they may have a much more serious threat in terms of number of earthquakes and size of earthquakes than our country does. Therefore, the chances or probability of a major earthquake occurring may be much higher than in our country.

Another factor, at least in some countries, is that their society or culture may be such that they are more able to deal with the responses that individuals and others may have to take if an earthquake were predicted. The question was posed by some of the people with whom we met: if an earthquake were predicted in California, how would the citizens react? I think some countries may be in a better position to just tell their citizens what they should do: I do not know if that is really feasible in our country. We have to develop much more sophisticated ways to handle the public's reaction to a predicted earthquake.

Mr. Brown. What you say is undoubtedly true. However, if you contrast the possible loss in an underdeveloped country, China as an example, with the United States, the figures become rather extraordinary.

Am I correct in recalling estimates of as high as $50 billion for a major earthquake in southern California?

Mr. Schuster. Yes, sir.

Mr. Brown. You would have to take care of most of China in order to get $50 billion.

Mr. Dodge. We are also talking about the loss of life and injuries in this, as I am sure you know. These events are very difficult to put dollar values on.

Mr. Brown. Do you have, or do you feel it is within your purview to offer any comments with regard to the possible effect of the reductions in the budget figures for NBS and the Geological Survey? I do not want to elicit anything that is not appropriate from you, but what do you see that as impacting? How do you see it as impacting the program?

Mr. Dodge. I am going to have to duck that one by saying, Mr. Brown, that we really did not cover that question with any directness in our review.

Mr. Brown. OK.

Are you sure you do not have any questions?

Mr. Boehlert. I would just add one here, Mr. Chairman.

Could you provide us with some examples of how other multiagency programs are structured organizationally to provide the type of control and leadership and direction that we are seeking here?

Mr. Dodge. There are a number of them that are statutory. They are set up by Congress. The one that we looked most closely at, as I mentioned, was the acid rain program, which has a statutory existence and which has a task force jointly chaired by three agencies to provide program leadership.

In that program the consolidated budget process is not a part of the statutory scheme, but has been arranged through OMB where the budget examiner is working very closely with the interagency process in the preparation of a joint budget on the acid rain program. This budget is not mandatorily followed by the agencies involved, but they take it as a starting point in their preparation of their individual budgets.

We look to that kind of a more integrated process as a useful model for application in the earthquake situation. There are several others that we could describe to you, either by submitting information for the record or by——

Mr. BROWN. Could you select four or five that you think would be pertinent and give us a brief description of them? I think I have asked you that question in the past.

You do not have a special unit over there that looks at complex interagency programs, do you?

Mr. DODGE. I wish we did. I wish we could say that there was an automatic set of criteria for measuring the appropriate ingredients of a smooth-functioning, interagency process, but, to our knowledge, there is no accepted set of criteria. However, we would be delighted to provide you the examples that we have pulled together in this regard.

Mr. BROWN. The one that comes to my mind, because of my personal involvement with it, is the national climate program. It has all sorts of headaches in it, too, as you know.

Mr. BOEHLERT. Mr. Chairman, I have just learned something new. This is the first time that I have learned that we have leadership and direction in our response to the acid rain problem. I would welcome some more information on that, if I could have it.

Mr. DODGE. The fact that there is an interagency mechanism does not mean that it has succeeded to date. A mechanism alone does not guarantee the leadership needed to address that problem, but in concept we would say that it is a model worth looking at.

Mr. BOEHLERT. Mr. Gregg, who is a sponsor of legislation to address the acid rain problem, I am sure will be looking at that very carefully, also.

Thank you.

Mr. BROWN. It is my understanding that the director of the acid rain program was formerly associated with this subcommittee, so that is probably the reason why it is such an excellent program. [Laughter.]

Mr. Gregg, would you have any questions to direct to the GAO representatives?

Mr. GREGG. Thank you, Mr. Chairman, but I have no questions.

Mr. BROWN. Thank you very much, Mr. Dodge. We appreciate that. We will scrutinize your report, of course, in much more detail. You may be excused.

[Information, requested by Mr. Brown from GAO on cooperative interagency models, submitted for the record. Information follows:]

MODELS FOR INTERAGENCY COOPERATIVE ARRANGEMENTS IDENTIFIED BY GAO

ACID PRECIPITATION PROGRAM

The Acid Precipitation Act of 1980 (Public Law 96-294) provided for the formation of an Acid Precipitation Task Force to implement the program. The Task Force is jointly chaired by the Secretary of Agriculture, the Administrator of NOAA, and the Administrator of EPA. According to its annual report, dated January 1982, the Task Force functions as an interagency board that oversees and manages the program. The Task Force attempts to meet at least three times a year to develop budgets, establish objectives, set priorities, approve plans and reports, and conduct program reviews.

One of the primary responsibilities of the Task Force is to produce an annual interagency budget for the Federal program. (The interagency budget does not commit an individual agency to a specific funding level. Each agency follows its own internal budget procedures in addition to going through its own appropriation committees.)

The Task Force has a Program Coordination Office which staffs the Joint Chairs in coordinating the planning and management of the program. The office is managed by the Task Force's Executive Director and includes personnel supported by Agriculture, EPA, and NOAA. The office and its interagency activities are funded by participating agencies.

NATIONAL CLIMATE PROGRAM

The National Climate Program Act (Public Law 95-367), passed in 1978, directed that the Secretary of Commerce establish within the Department a National Climate Program Office to be the lead entity responsible for administering the program. The act also directed the Secretary to (1) establish and maintain an advisory committee of users and producers of climate data, information, and services to advise the Secretary and the Congress on the conduct of the program, and (2) establish and maintain such interagency groups as are necessary and appropriate to assist in carrying out responsibilities under the act. Finally, the act required that each Federal officer, employee, department and agency involved in the program cooperate with the Secretary in carrying out the provisions of this act.

The act mandated that a 5-year plan be produced to "establish the goals and priorities for the Program" and contain details regarding "Federal funding required to enable the Program to achieve such goals." The Program's 5-year Plan, dated September 1980, identifies and describes two levels of priority activities within each of the major categories in the Program. The highest priorities are termed the Principal Thrusts of the Program. Each is a multidisciplinary multiagency effort with a designated lead agency. Activities at the second level of priority are termed Areas of Program Concern.

According to the Program's 5-year Plan, the Program is administered by the National Climate Program Office with the assistance and guidance of several interagency bodies plus the Climate Program Advisory Committee. The Office works with the concerned agencies, the Office of Science and Technology Policy, and the Office of Management and Budget in preparing and analyzing the budget proposals to implement the Program.

In 1979 the Secretary of Commerce established the National Climate Program Advisory Committee to review all aspects of the Nation's Climate activities and advise and report to the Secretary and the Congress on the conduct and priorities of the program.

COORDINATION MECHANISMS INVOLVING THE OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Over the last few years OSTP has initiated various coordination mechanisms involving government-wide science and technology issues. These are described in two publications: "Activities 1980--Federal Coordinating Council For Science, Engineering, And Technology," and "A Summary Of Accomplishments in FY 1982 By The Office Of Science And Technology Policy."

Examples of these coordination mechanisms include:

Committee on International Science, Engineering, and Technology

The purpose of this committee was to increase the effectiveness of Federal science, engineering, and technology activities carried out internationally by improving interagency cooperation in planning, budgeting for, and implementing these activities. There were some 20 departments and agencies represented on the committee including OSTP and the Office of Management and Budget.

Ad Hoc Committee on Automotive Research and Development

OSTP formed the Ad Hoc Committee on Automotive Research and Development which (1) provided policy review for the program plan of the Cooperative Automotive Research Program, (2) assisted in the definition of appropriate Federal agency roles and interagency relationships, and (3) provided fiscal information on which the overall program budget was based.

Committee on Materials

OSTP has led a 20-agency Committee on Materials to (1) prepare an inventory of all minerals and materials R&D in the Federal Government and (2) coordinate interagency activities on such items as advanced materials, materials availability, and basic materials research.

Mr. **Dodge**. Thank you, Mr. Chairman.

Mr. **Brown**. Our next witnesses will be Dr. Clarence R. Allen, professor of geology and geophysics at Cal Tech, and Dr. Otto W. Nuttli, professor of geophysics at St. Louis University.

We are very pleased to have you gentlemen with us. We know that you will give us an objective, unbiased, dispassionate analysis of this program and help us to keep it on track.

Joint Subcommittee on Human Nutrition Research

In September 1978 the OSTP Committee on Health and Medicine and the OSTP Committee on Food and Renewable Resources established the Joint Subcommittee on Human Nutrition Research to increase the overall effectiveness and productivity of nutrition research efforts. The subcommittee has been co-chaired by USDA and NIH. This subcommittee was made up of representatives from nine Federal departments and agencies involved in human nutrition research. This subcommittee's objectives include improving planning, coordination, and communication among Federal departments and agencies engaged in nutrition research.

NATIONAL OCEAN POLLUTION PLANNING ACT

The National Ocean Pollution Planning Act of 1978 designated NOAA as the lead agency to develop a 5-year plan to better coordinate ocean pollution research. The act specified that proposals could be made in the plan for interagency cooperation to help eliminate duplication.

To advise NOAA in carrying out its mandate, the President's Science Advisor chartered the Interagency Committee on Ocean Pollution Research, Development, and Monitoring (COPRDM) as a standing committee of the Federal Coordinating Council for Science, Engineering, and Technology. The Committee was chaired by NOAA's Deputy Administrator and its members were senior policymakers in Federal agencies that perform ocean pollution studies. A representative of OMB was also a member. The National Marine Pollution Program Office (NMPPO) was established as part of NOAA in 1979 to (1) prepare and revise the plan, (2) coordinate its implementation, and (3) provide staff support to the COPRDM.

[The biographical sketch of Dr. Allen follows:]

BIOGRAPHICAL SKETCH

CLARENCE R. ALLEN

Dr. Clarence R. Allen is Professor of Geology and Geophysics at the California Institute of Technology in Pasadena, California. He is in charge of Caltech's responsibilities for the 115-station Joint USGS-Caltech Southern California Seismographic Network, and most of his research has concerned the nature and seismic hazard of major active fault systems in various parts of the world. Dr. Allen was Vice Chairman of the American Earthquake Prediction Delegation to the People's Republic of China in 1974, and Chairman of the Plate Tectonics delegation to China (Tibet) in 1979. He has served as President of both the Geological Society of America and the Seismological Society of America, and he has been elected to membership in both the National Academy of Engineering and the National Academy of Sciences. Presently he serves as Chairman of the National Academy of Sciences' Geology Section and as Chairman of the National Earthquake Prediction Evaluation Council. He is also a member of FEMA's Independent Review Panel to review and report on the 5-year program (FY83-FY87) of the National Earthquake Hazards Reduction Program.

STATEMENT OF CLARENCE R. ALLEN, PROFESSOR OF GEOLOGY AND GEOPHYSICS, CALIFORNIA INSTITUTE OF TECHNOLOGY

Dr. ALLEN. Mr. Brown, I am Clarence Allen.

I am honored to appear before the subcommittee once again.

I appear here as a private citizen, not representing any particular group, although I think my views are representative of a wide spectrum of scientists and engineers who have been involved in this program.

Although I cannot speak officially for FEMA's Independent Review Panel, I have served on that panel, as has Dr. Nuttli, and I am generally sympathetic with its directions of thinking.

Most of us who are involved in the earthquake hazard reduction effort and who can speak in an unconstrained fashion are deeply distressed at the proposed budget reductions in the program for fiscal year 1984, particularly in that part of it assigned to the U.S. Geological Survey. With the proposed reductions and their implication for the future, it does not seem possible to maintain adequate momentum, much less meet in any sort of a timely fashion the objectives of the original 1977 legislation.

I am particularly worried about the balance in the overall program, and it seems strange that some parts of the program, such as that carried out by the National Science Foundation, are facing modest budget increases, whereas very closely allied parts of the program sponsored by the USGS are facing very large cuts. This seems to reflect individual departmental priorities, rather than any kind of a coordinated national policy such as was envisaged in the 1977 legislation. In view of the President's laudable efforts to sustain the country's scientific and technical leadership, I find this budgetary situation rather difficult to understand.

I have been asked by your staff to comment on FEMA's performance as the designated lead agency in the national earthquake program. In my opinion, FEMA's efforts have not been satisfactory to date, although this may be largely the result of failure by both FEMA and the involved agencies adequately to define what is meant by lead agency.

I think that there is now, at last, some meeting of the minds on this problem, and I am reasonably optimistic that FEMA's role can, indeed, be a more constructive one in the future.

In particular, in my opinion, FEMA needs—and I think other members of the panel agree with me on this—to appoint someone of national stature to handle its lead agency responsibilities and to act as an advocate and a spokesperson at the national level for the entire broad program. No one is currently doing this. Every person is arguing for his own part of it, and the program has suffered accordingly.

In my opinion, FEMA should not control the earthquake budgets or programs of the individual agencies, and the last thing we need is some sort of a czar to manage the program. However, a more effective and recognized spokesperson to work in a statesmanlike roll with Congress, the OMB, the participating Federal agencies, State agencies, and the scientific-engineering community should help to avert some of the unhappy budgetary and coordination situations that now face the program.

It would also be wise, in my opinion, for a standing earthquake advisory committee to be set up at the national level, reporting to the Director of FEMA, and broadly representative of not only the scientific and engineering communities, but also of users, such as State and local government. The makeup of FEMA's present review panel might be used as a model.

I conclude, therefore, that FEMA should be given a renewed chance to give leadership to the national earthquake program, albeit recognizing its past failures. Certainly, no other agency seems to be a more logical choice, in view of the wide variety of interests and disciplines involved and the wide variety of constituencies to be served.

I think that we can all be proud of the accomplishments of the national earthquake hazard reduction program to date. Significant, and even very spectacular, progress has been made in some areas, whereas other areas have not progressed as rapidly as we had hoped. Such is the nature of any innovative effort, and we must be careful not to be too shortsighted in our evaluation of various parts of the program at this time.

I personally have been involved deeply in the earthquake prediction effort, and our progress in short term prediction is one of those areas where our progress has not been as rapid as we had hoped 5 years ago. On the other hand, progress in long-term prediction has been far more rapid than any of us envisaged at the start of the program, and in the long run it is my guess that this may turn out to be more important to the public than the short-term predictions, anyway.

For the first time, for example, we now have a firm, quantitative estimate of exactly what the likelihood is of a great earthquake on the San Andreas Fault opposite Los Angeles, and I am personally optimistic that some of these same techniques will be applicable to areas in the Central and Eastern United States where, although the earthquake hazard is obviously considerably less, our understanding of the exact level of risk is also much less.

At the present time, for example, I am convinced that we can site and design nuclear plants on the west coast with greater confidence that we have met an acceptable safety standard than we can on the east coast, where the earthquake risk is clearly less but also far less well understood.

Although it may be partly our own fault, I personally regret that much of the public seems to have come to associate earthquake hazard reduction with short-term earthquake prediction alone, whereas this is only one of many efforts within the overall hazard reduction program. Indeed, as I mentioned before, in my opinion, many other aspects of the program, such as engineering studies and probabilistic hazard assessments, are equally, and perhaps even more, critical to a solution of the overall earthquake problem than is short-term earthquake prediction.

Another area in which I was asked to comment by your staff is that of the role of basic research versus more applied efforts in the earthquake prediction program. We seem to be under some pressure to, so to speak, get on with it in installing earthquake-prediction-monitoring networks, rather than spending so much effort on allegedly more esoteric earthquake-prediction research. I only wish that this were possible, but the unhappy facts are that we do not yet know how to predict earthquakes on any kind of a routine basis, nor do we know exactly what kinds of instruments should best be installed in such an operational network, nor does anyone else in the world.

The idea that the Japanese or the Chinese have this knowledge, and we do not, is simply not in keeping with the facts, although it is indeed true that both of those countries are making greater efforts in the earthquake-prediction field than are we in the United States. They also have more earthquakes to experiment on. They are more able to absorb false alarms than we are. There are a number of reasons for the fact that the Chinese have occasionally been successful. They have also failed many, many times.

I agree with the USGS that the time is ripe to experiment with some prototype prediction networks in highly seismic areas such as southern California, but it would be naive to think that these would be truly operational facilities rather than simply research tools. If there is one thing we have learned in the past 5 years, it is that the earthquake prediction problem is a more difficult one than we had thought, and in my opinion we clearly need a better understanding of the physical nature of earthquakes. This continues to demand a very strong, basic research element in the overall program. Such work is, and I think should be, supported to some degree by both the NSF and the USGS.

Let me close by saying that there is no doubt in my mind but that the earthquake problem is a solvable one—solvable by better engineering, better land-use planning, better hazard assessment, better public awareness and education, and better prediction of forthcoming events. There is not the slightest doubt but that we can learn to live safely with earthquakes, although we have a long way to go to reach that goal. In many ways, it seems to me, earthquakes represent a far more tractable engineering and scientific problem than do the hazards posed by some other natural events such as hurricanes and tornadoes. Particularly under the national earthquake hazards reduction program of the past 5 years, very significant progress has been made toward meeting our goals. It would be a tragedy to lose this momentum now.

Thank you.

[The prepared statement of Dr. Clarence R. Allen follows:]

WRITTEN STATEMENT OF CLARENCE R. ALLEN,

PROFESSOR OF GEOLOGY AND GEOPHYSICS, CALIFORNIA INSTITUTE OF TECHNOLOGY

Submitted to

U. S. HOUSE OF REPRESENTATIVES COMMITTEE ON SCIENCE AND TECHNOLOGY

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

15 March 1983

Mr. Chairman, I am honored to be asked to appear before this Subcommittee to discuss to the nation's earthquake hazard-reduction effort. I appear here as a private citizen, although representative—I think—of a wide spectrum of scientists and engineers who have been deeply involved in this effort. And although I cannot speak officially for FEMA's Independent Review Panel on the 5-year Program Plan (FY83-FY87) of the National Earthquake Hazards Reduction Program, I have served on that Panel and am aware of, and generally sympathetic with, the directions of its thinking.

Most of us involved in the earthquake-hazard reduction effort are deeply distressed at the proposed budget reductions in the program for FY84, particularly in that part of it assigned to the U. S. Geological Survey. With the proposed reductions and their implication for the future, it does not seem possible to retain adequate momentum, much less meet the objectives of the original 1977 legislation. I am particularly worried about balance in the overall scientific program, and it seems strange that some parts of the program, such as that carried out by the National Science Foundation, are facing modest budget increases, whereas very closely allied parts of the program sponsored by the USGS are facing large cuts. This seems to reflect individual Departmental priorities and budgetary tactics rather than any kind of a coordinated national policy such as was envisaged in the 1977 legislation. And in view of the President's laudable efforts to sustain the country's scientific and technical leadership, I find this budgetary situation particularly difficult to understand.

I have been asked by your staff to comment on FEMA's performance as the designated lead agency in the national earthquake program. In my opinion, FEMA's efforts have not been satisfactory to date, although this may be largely the result of failure by both FEMA and the involved agencies adequately to define the role of the "lead agency." I think that there is now, at last, some meeting of the minds on this problem, and I am reasonably optimistic that FEMA's role can indeed be a more constructive one in the future. In particular, FEMA needs to appoint someone of national stature to handle its lead-agency responsibilities and to act as an advocate and spokesperson at the national level for the entire broad program; no one is currently doing this, and the program has suffered accordingly. Obviously FEMA will not and should not control the earthquake budgets or programs of the individual agencies, and the last thing we need is a czar to "manage" the program. But a more effective and recognized spokesperson to work in a statesmanlike roll with Congress, the OMB, participating Federal agencies, State agencies, and the scientific-engineering community should help to avert some of the unhappy budgetary and coordination situations now facing the program.

It would also be wise, in my opinion, for a standing earthquake-advisory committee to be set up at the national level, reporting to the Director of FEMA, and broadly representative of not only the scientific and engineering communities, but also of "users" such as State and local government. The makeup of FEMA's present Review Panel might be used as a model. I conclude, therefore, that FEMA should be given a renewed chance to give leadership to the National Earthquake Hazards Reduction Program, albeit recognizing its past failures; certainly no other agency seems to be a more logical choice, in view of the wide variety of interests and disciplines involved and constituencies to be served.

I think that we can all be proud of the accomplishments of the National Earthquake Hazard Reduction Program to date. Significant and even spectacular progress has been made in some areas, whereas some other areas have not progressed as rapidly as we had hoped. Such is the nature of any innovative effort, and we must be careful not to be too short-sighted in our evaluation of various parts of the program. I personally have been involved deeply in the earthquake-prediction effort, and our progress in short-term earthquake prediction (i.e., prediction of events within hours or days) is one of those areas where our progress has not been as rapid as envisaged five years ago. On the other hand, progress in long-term prediction (i.e., identification of especially dangerous areas, and quantitative hazard assessments within those areas) has been far more rapid than any of us envisaged at the start of the program, and, in the long run, this may in fact turn out to be more important to the public than short-term predictions. For the first time, for example, we now have a firm quantitative estimate of exactly what the likelihood is of a great earthquake on the San Andreas fault opposite Los Angeles, and I am optimistic that some of the same techniques will be applicable to areas in the central and eastern United States where--although the earthquake hazard is obviously less than that in the west--our understanding of the exact level of risk is also considerably less. At the present time, for example, I am convinced that we can site and design nuclear plants on the west coast with greater confidence that we have met an acceptable safety standard than we can on the east coast, where the earthquake risk is clearly less, but also far less well understood.

Although it may be partly our own fault, I personally regret that many members of the public seem to have come to associate earthquake-hazard reduction with short-term earthquake prediction alone, whereas this is only one of many efforts within the overall hazard-reduction program. Indeed, in my opinion, many other aspects of the program, such as engineering studies and probabilistic hazard assessments, are equally and perhaps even more critical to solution of the overall "earthquake problem" than is short-term earthquake prediction.

Another area in which I was asked to comment by your staff is that of the role of basic research vs. more applied efforts in the earthquake-prediction program. We seem to be under some pressure to "get on" with installing earthquake-prediction monitoring networks rather than spending so much effort on seemingly more esoteric earthquake-prediction research. I only wish that this was possible! But the unhappy facts are that we don't yet know how to predict earthquakes on any kind of a routine basis, nor do we know exactly what kinds of instruments should best be installed in such an operational network. Nor does anyone else in the world. The idea that the Japanese or the Chinese have this knowledge and we don't is simply not in keeping with the facts, although it is indeed true that both of those countries are making greater efforts in the earthquake-prediction field than are we in the United States. I agree with the USGS that the time is ripe to experiment with some prototype prediction networks in highly seismic areas such as southern California, but it would be naive to think that these would be truly operational facilities rather than research tools. If there is one thing we have learned in the past 5 years, it is that the earthquake-prediction problem is a more difficult one than we had thought, and, in my opinion, we clearly need a better understanding of the physical nature of earthquakes. This continues to demand a very strong basic-research element in the overall program. Such work is, and should be, supported to some degree, by both the NSF and the USGS.

Let me close by saying that there is no doubt in my mind but that the "earthquake problem" is a solvable one--solvable by better engineering, better land-use planning, better hazard assessment, better public awareness and education, and better predictions of forthcoming events. That is, there is not the slightest doubt but that we can learn to live safely with earthquakes, although we have a long ways to go to reach that goal. In many ways earthquakes represent a far more tractable engineering and scientific problem do than those posed by other natural hazards such as hurricanes and tornadoes. Particularly under the National Earthquake Hazards Reduction Program of the past five years, very significant progress has been made toward meeting our goals. It would be a tragedy to loose this momentum now.

Mr. **Brown**. Thank you very much, Dr. Allen.

Dr. Nuttli, you may proceed with your statement.

[The biographical sketch of Dr. Nuttli follows:]

BIOGRAPHICAL SKETCH

Otto W. Nuttli is Professor of Geophysics at Saint Louis University. He received B.S., M.S. and Ph.D. degrees in geophysics from Saint Louis University, and has been a member of its faculty since 1952. He is a fellow of the American Geophysical Union and is a member of the Seismological Society of America, the Earthquake Engineering Research Institute, the Society of Exploration Geophysicists and the Royal Astronomical Society. He has served as president of the Seismological Society of America, as editor of the Bulletin of the Seismological Society of America, and as an associate editor of the Journal of Geophysical Research. His principal fields of research are seismology and earthquake engineering, with emphasis on the eastern United States.

STATEMENT OF OTTO W. NUTTLI, PROFESSOR OF GEOPHYSICS, DEPARTMENT OF EARTHQUAKE AND ATMOSPHERIC SCIENCE, ST. LOUIS UNIVERSITY

Dr. **Nuttli**. Thank you, Mr. Brown.

At the request of the staff, I shall summarize my testimony on the earthquake hazard in the eastern part of the country.

There are two points that I wish to make in this testimony. The first one is that earthquake hazard is not limited to the West. Earthquakes large enough to cause structural damage already have occurred in 14 States east of the Rocky Mountains. Some of these earthquakes also cause much damage in the surrounding States. In fact, the three major eastern earthquake-source zones, which are the Mississippi River Valley Zone, the St. Lawrence River Valley Zone in Canada, and the Charleston, S.C., area, taken together, can produce earthquakes that can cause damage in every State east of the Rocky Mountains.

In addition, there are more than 10 other earthquake-source zones in the East that have produced, and will continue to produce, damaging earthquakes. Fortunately, the large earthquakes occurred during the time when our country was sparsely populated. Since it takes time for the geological forces to build enough energy to cause more large earthquakes, we have been in a quiet period in the 20th century, at least up until the present time. However, I am fairly confident that this quiet spell is not going to continue indefinitely in the future.

The second point is that there have been a large number of accomplishments under the national earthquake hazards reduction program, but still there is much that remains to be done to achieve the goals of that program. Some of the information learned is now being used already in the design of critical facilities and other important structures, but we still need to know more about the boundaries of the earthquake-source zones, the frequency of occurrence of earthquakes in them, and the strength of the ground-shaking caused by large earthquakes.

We have to be patient to get this information because eastern earthquakes occur much less frequently than the ones in the West. However, as we do get more data, we will be able to do an even better job of estimating earthquake hazard. In some cases this will result in reduced construction costs for critical facilities, such as dams, nuclear processing plants, highway bridges, and so forth, because the structures now may be overdesigned because we do not know enough about the earthquake hazards. In fact, I think the savings which might accrue for just one such structure could exceed the total annual budget for the full NEHRP.

The results and findings of the NEHRP are presently being put to use by State and local agencies as well as by Federal agencies.

I will be glad to elaborate on these points, if you wish to ask me any further questions. Thank you.

[The prepared statement of Dr. Otto W. Nuttli follows:]

TESTIMONY BY OTTO W. NUTTLI,

PROFESSOR OF GEOPHYSICS, SAINT LOUIS UNIVERSITY

SUBMITTED TO THE

HOUSE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

MARCH 15, 1983

Mr. Chairman, I am pleased to appear before the House Subcommittee on Science, Research and Technology and to discuss, at your request, the current activities of the National Earthquake Hazards Reduction Program as it relates to earthquake problems in the eastern United States.

INTRODUCTION

There are two principal points I wish to make in this testimony. The first is that earthquake hazard in the United States is not restricted to the West, but also exists in varying degrees, in almost every state of the nation. The second point is that work accomplished under the Hazard Recuction Program has produced a number of significant accomplishments.

EARTHQUAKE HAZARD IN THE EAST

Earthquakes do not occur regularly in time. After great earthquakes, there is a period of relative quiet until the ever-acting geological forces are able to produce sufficient strain to cause more large earthquakes. The twentieth century has been such an interlude for catastrophic seismic activity in the eastern states. Therefore, because there have been no major eastern earthquakes in the memory of most of the people, the general populace is insufficiently informed about the earthquake hazard east of the Rockies. Recently we have had several small reminders of this threat in the form of moderately damaging earthquakes in New Brunswick, Canada and New Hampshire in January 1982, and of a 1980 Kentucky earthquake that was felt in fifteen states and in Canada and that caused several million dollars of property damage in Kentucky and Ohio.

In historical times structurally damaging earthquakes occurred in

Alabama, Arkansas, Connecticut, Delaware, Illinois, Indiana, Kansas, Kentucky, Maine, Massachusetts, South Carolina, Tennessee, Texas and Virginia. For some of them, damage was also experienced in neighboring states, such as Georgia, Mississippi and North Carolina.

Fortunately, the great eastern earthquakes occurred before the country was densely populated, and before the appearance of high-rise structures and the development of a sophisticated and vulnerable technological society. The 1886 Charleston, SC earthquake, of magnitude 7.5, killed 110 people. If it had happened 100 years later, the loss of life would have been at least ten times, and conceivably one hundred times, greater. Even more dramatic were the three great New Madrid earthquakes in the winter of 1811-1812, with epicenters in Arkansas and Missouri and magnitudes of 8.4, 8.6 and 8.7. Ground shaking caused by them was felt in all of the United States east of the Rockies, and perhaps farther to the west. Damage extended over most of the area consisting of the states of Missouri, Arkansas, Mississippi, Kentucky, Tennessee, Illinois, Indiana and Ohio. Other large nineteenth century earthquakes occurred in eastern Arkansas in 1843, in Charleston, Missouri in 1895 and in Giles County, Virginia in 1897.

From our studies of the New Madrid fault we know that enough energy is stored up along it to produce a magnitude 7.6 earthquake right now. This would cause damage over an area of 200,000 square miles. However, we are not yet able to predict when the next large earthquake will occur. The longer the time that elapses, the larger the earthquake will be. For the rest of the eastern United States we cannot be so specific about the seisimic potential. Further data accumulation and research are needed to provide us this information.

SOME ACCOMPLISHMENTS FOR THE BENEFIT OF THE EAST OF THE NATIONAL HAZARDS REDUCTION PROGRAM

The National Science Foundation, the U.S. Geological Survey, the Federal Emergency Management Agency and the U.S. Nuclear Regulatory Commission are the principal federal agencies that engage in earthquake-related activities in the eastern United States. Other important participants are state and local agencies, universities, private industry, and non-profit organizations such as the American Red Cross.

Significant accomplishments under the National Earthquake Hazards Reduction Program span the whole range of goals of earthquake hazard mitigation. I shall limit my examples to those with which I have personal experience, and they will reflect my background as a seismologist.

On the scientific level we are making progress in our ability to define the boundaries of the major earthquake source zones, to determine the frequency of occurrence of earthquakes within those zones, and to estimate the largest earthquake that each area is capable of producing. We also are acquiring quantitative information about the attenuation of high frequency seismic waves that produce damaging ground shaking. These kinds of information are needed to calculate the expected amount of ground shaking at any selected site, which in turn is needed for the design of earthquake-resistant structures. All of the seismic information comes from the continued operation of seismograph networks, from regional geological and geophysical studies, and from fundamental seismological research on the physics of the rupture process, the transmission of wave energy, and the geological structure of the Earth's crust. The problems to be solved are especially difficult because eastern earthquakes, in general, do not rupture the Earth's surface (the faults can't be seen), the earthquakes occur relatvely infrequently, and the association between geological processes and earthquake occurrence is not as well known or understood as it is in the West. Therefore a long-term research effort is required for a better understanding of the seismicity and tectonics of the East, which comprise the most fundamental kinds of earthquake information.

In the past few years earthquakes in Arkansas, Kentucky, Missouri, New Brunswick, New Hampshire and South Carolina provided the first eastern strong ground-motion records. These kinds of data are essential to the engineers who design structures. Also seismologists use them to compare actual observations with those predicted from theoretical studies, to check their theory, and to determine similarities and differences with western earthquakes. Until now engineers have relied upon modified western data in designing seismic-resistant structures for the East, even though there is uncertainty as to how the data should be modified.

Strong ground-motion data still are lacking for large magnitude eastern earthquakes. Continued operation of strong ground-motion instruments in the East is needed to obtain these data. Along with this, fundamental studies of earthquake source physics and of wave propagation will enable us to better "scale up" motions from small to large earthquakes, to speed the acquisition of this essential information.

From personal experience I know that the results of the aforementioned studies already are being used by engineers in the design of nuclear power facilities and reprocessing plants, large dams and selected high-rise structures. It is gratifying that this NEHRP-derived knowledge is being used so immediately to reduce earthquake risk in the eastern United States. In some cases ths is being done only because of requirements of federal regulatory agencies, or because of the initiative of individual engineers and architects who are responsible for the design of high-rise and/or critical structures. In general, there are no seismic building code requirements in most of the eastern United States. However, progress is being made along these lines also.

The U.S. Geological Survey and the Federal Emergency Management Agency have taken the lead in bringing the earthquake hazard problem to the attention of state and local officials, structural engineers, and agencies responsible for building codes, land-use planning, and for engineering response to disasters. Well-attended conferences and workshops on these topics include:

Knoxville, Tennessee workshop in September 1981, "Preparing for and Responding to a Damaging Earthquake in the Eastern United States."

Saint Louis, Missouri workshop in May 1982, "Continuing Actions to Reduce Losses from Earthquakes in the Mississippi Valley Area."

Charleston, South Carolina conference in May 1982.

Three additional workshops are to be held in 1983 in Charleston, South Carolina, Boston, Massachusetts, and Little Rock, Arkansas. These conferences are organized by the U.S. Geological Survey, with support shared by the Federal Emergency Management Agency, the National Science Foundation and the U.S. Nuclear Regulatory Commission. The published proceedings of these conferences are widely distributed and have received attention not only from technical people and state and local officials, but also from the press, TV and radio, insurance underwriter organizations, school officials, and other groups of concerned citizens. Because of these activities carried out under the NEHRP, the eastern earthquake hazard problem is beginning to get the attention of the public and of government officials responsible for mitigating earthquake effects or of responding to earthquake disaster. This educational process much be long-term and continuous in nature, if it is to achieve the desired goals.

At the state level, I am aware of some kind of governmental action regarding earthquakes in Kentucky, Massachusetts, Missouri, New York and Tennessee. There may be more, of which I am unaware. At the local level my experience is limited to metropolitan St. Louis. At present there is an Ad-Hoc Committee on Seismic Risk of the St. Louis Section of the American Society of Civil Engineers, and a continuing concern of St. Louis County Civil Defense for educating school children for safe behavior during an earthquake, and also for planning their response to earthquake-caused emergencies.

I have attempted to cover the range of NEHRP-related activities in the East. There is one final point I wish to make. It concerns the need to continue the research efforts. The members of the House Subcommittee on Science, Research and Technology are well aware of the inherent values of research, so there is no need for me to spell them out to you. But with regard to the National Earthquake Hazard Reduction Program, there is a cost-effective reason which may not be obvious. Critical facilities are designed to withstand the worst likely earthquake. Because our knowledge is incomplete, this can result in overdesign. As we better understand the earthquake hazard through the research effort, we will find that for certain parts of the country, at least, the worst likely earthquake hazard will be less than is presently assumed. This will allow for a less costly, but equally safe, design of the structures. The expected savings in construction costs can conceivably be orders of magnitude larger than the entire cost of the NEHRP. In addition, more precision and detail in mapping earthquake hazard will make it easier to get local communities to adopt efffective building codes, for the additional construction costs will not be so burdensome.

I trust, Mr. Chairman, that my testimony will provide you and the members of the Committee on Science and Technology with a fuller knowledge of the actions, resulting from the NEHRP, that have been and are being taken to mitigate earthquake hazard in the East, and of the need for continuing efforts in all aspects of the Program.

Mr. **Brown**. Thank you very much, Dr. Nuttli.

Dr. Nuttli, is there a theoretical explanation in geological circles for the occurrence of earthquakes in areas that are not at the boundaries of so-called tectonic plates?

Dr. **Nuttli**. I think we are getting a much better understanding, Mr. Brown, of the cause of these earthquakes, thanks in great part to the NEHRP. We have learned a lot over the past five to seven years.

We do know, for example, in my home area, which is Missouri, that the New Madrid Fault Zone, that it was once an ancient rift zone. About 1 billion years ago this feature formed within the Earth's crust, trying to tear it apart, and left a zone of weakness. From plate tectonics, we know we have crustal material being spread from the middle of the Atlantic Ocean and trying to push North America to the west, but it is prevented from going further west by the San Andreas Fault. It is a kind of a barrier. As a result, the North American Continent is being squeezed together in an east-west direction. This east-west compression, along with the old scar of the rift, tends to concentrate the strain around the New Madrid Fault Zone. Therefore, we believe that is the reason we have the large earthquakes there.

That is something we could not have said 10 years ago.

Mr. **Brown**. Dr. Allen, you refer to the loss of momentum in the program as a result of the reductions in budgetary allocations for the Geological Survey and, likewise, the National Bureau of Standards. I wonder if you could elaborate on that a little bit.

I think we all recognize that we face some periods of budgetary stringency and that there are going to have to be sacrifices made. The question is the rationality of some of these sacrifices and whether or not we may lose more than we gain by the temporary reduction in funds.

I am interested in a better understanding as to what you mean when you refer to the loss of momentum here. What are the adverse effects likely to be?

Dr. **Allen**. I think Dr. Peck himself outlined some of the difficult things that he was going to have to do to live within next year's budget. These included, for example, serious cutbacks in the entire USGS program of theoretical and laboratory studies of earthquakes. We are never going to predict earthquakes, frankly, on any kind of a routine basis unless we develop understanding of what is really going on down there where earthquakes originate. That is an area that I hate to see being cut back. Yet, clearly, according to Dr. Peck's own testimony, this is one of the areas in which we will be losing significant momentum.

Some of the seismographic networks that we have set up in many parts of the country, particularly outside of southern California, as Dr. Peck has clearly stated, simply cannot continue to be supported. This will not only have, I think, serious scientific effects, but also in many ways will reduce the political sponsorship of the program on a countrywide basis, which I hate to see happen.

I think it is clear that we will lose much of the momentum that is now going.

Mr. **Brown**. Can either of you gentlemen tell me how adequate our exchange of information is with some of these other countries which have ongoing programs? I am thinking of Japan, in particular.

Dr. **ALLEN**. I have been to China six times now. I can say that our communication with Chinese scientists is very, very good. And we have a very strong cooperative program under NSF sponsorship with the Japanese. These have been very fruitful programs, I think, for all three countries. Dick Andrews may later state some of the things he saw during his recent visit to Japan.

The Russian cooperative program clearly has slowed down. This has been an area which, although we had good communications some time ago, has tapered off together with many other aspects of our relationships with Russian scientists.

However, I would say in terms of the Chinese and Japanese programs, that communication is excellent.

I think we have a good deal to learn from one another. The Chinese are not necessarily ahead of us. They have had some prediction successes; they have also had many, many failures. However, there are many things I think we can learn from the Chinese.

For one thing, they have many earthquakes to experiment on which we simply do not have. They have had broad experience in looking at some of the effects of, say, ground water-level changes, and even such things as animal behavior, that we have not had. I think there is no question that we have a good deal to learn from them, as they do from us, with our more sophisticated instrumentation.

Mr. **BOEHLERT**. Mr. Chairman, may I ask something here?

Is it an organized program for exchange or is it on an ad hoc basis?

Dr. **ALLEN**. There are several organized programs. The USGS and the NSF, for example, have a protocol with the Chinese specifically in earthquake-prediction and earthquake engineering studies. There is one area near Peking, and another in Yunnan Province, which are undergoing joint study by scientists from the two countries.

The National Academy of Sciences has its own program of sending scholars back and forth in various fields, including seismology.

Mr. **BROWN**. Were you going to comment, Dr. Nuttli?

Dr. **NUTTLI**. Yes. With the support of the National Science Foundation, I have a Chinese seismologist working with me on some problems of earthquakes in China, wave propagation of earthquake energy in China, and things of that sort. This is a one-way proposition, rather than an exchange, but I think it has been mutually beneficial to both of us.

Some of the problems are similar in the United States to China, and others are quite different. It broadens our outlook on the nature of the earthquake process itself to see some of these differences.

Also, our Government is making available to us copies of Chinese seismograms, so we have a new research tool available to us that we did not have a few years ago.

Mr. **BROWN**. Both of you gentlemen are Earth scientists, I guess. Can you explain to me why the Chinese effort seems to include a component of what we would consider folk knowledge and ours pays relatively little attention to this? That is the sort of things you mentioned, animal observations——

Dr. ALLEN. I think there are several factors involved here. One is that most people who have been killed in Chinese earthquakes were in their own homes or their own apartment structures, which collapsed. Consequently, it is true in China that an obvious way to save lives during earthquakes is to predict the earthquake and get people out of those structures. Therefore, earthquake prediction has had an exceedingly high priority in China—more so than in this country. In southern California, for example, one of the safest places you can be during an earthquake is in your own home. Therefore, our effort has not been so heavily weighted toward prediction alone, and it has placed more emphasis on other parts of the total hazard reduction effort as compared to the Chinese program.

Furthermore, the Chinese do not have the abundant instruments we have. They do not have the prospects of sophisticated instrumentation. Therefore, they have been much more apt to turn to amateur types of measurements simply out of necessity, and these efforts have paid off to some degree for them.

I think many of their water level observations have been valid and significant. Some of their meaningful radon observations have been carried on in high schools, and even some of the animal behavior reports cannot be completely scoffed at. I think we have to place a certain amount of credence in many of these reports.

However, it is our opinion in this country that whatever the animals are sensing, if anything, should better be detected with instruments. Therefore, our emphasis is on instrumentation rather than on asking people out in the field—out on the farms—to study the behavior of their animals.

Nevertheless, I wish there were more ways in which we could get the public involved in these studies, constructive ways—school children, farmers, people out in the field, or some such thing, and we constantly are searching for ways that have some real scientific meaning, to get people involved in the programs that might help us in this overall effort.

Mr. BROWN. Isn't it a legitimate scientific effort to determine what it is that the animals respond to, if in fact they do respond to some prepressure phenomenon?

Dr. ALLEN. I think the biggest problem is demonstrating unequivocably that they really do respond. We have lots of evidence suggesting that but, nevertheless, hard scientific facts are few, and it is very difficult to come up with convincing evidence that a given group of animals did a particular thing prior to an earthquake, responding to something that you and I would not sense.

Mr. BROWN. Isn't it at least possible that they are responding to a level of shock that is not felt by human beings but would be noticed by instruments?

Dr. ALLEN. Certainly that is true. There are many reports, for example, of birds flying off trees before earthquakes, and I think those are quite easily explained in terms of minor foreshocks that the birds felt but that you and I did not. Nevertheless, I think we can design instruments that will far better detect and measure those foreshocks in a quantitative way than can any birds.

Mr. **Brown**. What about the radon gas? We have made efforts to measure those, haven't we?

Dr. **Allen**. We have had a rather large effort in radon measurements because some of the reports coming out of both the Soviet Union and China have been very intriguing—certainly worth looking at. Therefore, we have set up, primarily under Geological Survey sponsorship, a number of programs in California. To date, I would say we have learned a lot about why radon is present in ground water, and there have been some rather interesting scientific results in terms of climatic effects on radon content. I cannot say at the moment, however, that these studies have given us any great insights into earthquake prediction, although it certainly is not an effort that we are ready to terminate.

Mr. **Brown**. Mr. Gregg, do you have any questions?

Mr. **Gregg**. No, Mr. Chairman.

Mr. **Brown**. Mr. Boehlert, do you have any questions?

Mr. **Boehlert**. Yes. I would like to pursue something just a little bit.

Excuse me. This is my first exposure to this subject, being from beautiful upstate New York where earthquakes are always considered something that happen far away.

Dr. **Allen**. Well, upstate New York—strange you should mention it. [Laughter.]

Mr. **Boehlert**. Fortunately, in my short lifetime we have not been exposed much to it.

Are there international forums where scientists from all nations really get together to address the subject in a scholarly manner and to exchange information, or is it just something where you have someone from China working with you, Dr. Nuttli, or you, Dr. Allen, and then you go to China on a visit? Is there really a working international forum, a vehicle, for people such as yourselves to exchange with people from other nations the information you have developed and to, in turn, receive what they have developed?

Then I would like you to address the concern that I should have for my family in upstate New York, if you will, Dr. Allen.

Dr. **Nuttli**. First of all, there is a forum such as that. There is the International Union of Geodesy and Geophysics. In fact, it meets every 4 years on a complete basis, and it meets every 2 years on a topical basis, for example, seismologists have their own international meeting every 2 years.

Our next meeting is this August in Hamburg, Germany. It is the complete Union of Geodesy and Geophysics.

There is a very good interchange of ideas and knowledge at these meetings. Representatives from the Soviet Union, China, Japan, Asia, India, almost all of the countries of the world, in fact, show up at this.

Mr. **Boehlert**. Thank you.

Dr. **Allen**. This is also an area where UNESCO has done, I think, some significant and constructive work. I personally am skeptical of much of what UNESCO has done in other areas, but they happen to have stimulated a great deal of international communication in earthquake-related fields, and UNESCO has sponsored a number of meetings in this area of prediction and response to predictions that have been very constructive, in my opinion.

Dr. Nuttli. In New York there are essentially two earthquake zones. One is in the east, with most of the biggest earthquakes occurring at the present time in the northeast part of the State and another in the west, toward Attica, N.Y. In that area there were big earthquakes in the 1920's. They caused damage over several counties.

The eastern New York seismicity is part of the general earthquake problem of New England. It is of much concern.

Mr. Boehlert. Thank you.

My mother is fortunate enough to live in southern California, so I am concerned for her, too. [Laughter.]

Mr. Brown. Mr. Dymally.

Mr. Dymally. I have nothing, just an informational question.

What time in August is the meeting?

Dr. Nuttli. It is a 2-week meeting. I believe it starts on August 15 through August 29 or 30.

Mr. Brown. Are you planning your itinerary, Mr. Dymally?

Mr. Dymally. Surely, you need some congressional observers. [Laughter.]

Mr. Brown. Did either of you gentlemen participate in that recent conference in Los Angeles last month that was sponsored by I think FEMA and AID? It was an international conference on earthquake response.

Dr. Allen. Yes, I did. I gave, I guess, the initial talk at the conference.

Mr. Brown. Oh, yes. I gave the final talk. [Laughter.]

I was rather interested in what I heard about the participation in that conference. Apparently, it was well attended and it was intended to exchange information on all aspects of earthquake response, and prediction I presume is part of it. I gathered that some of the countries there perhaps had programs comparable or more advanced than our own. Is that a fair statement?

Dr. Allen. Certainly, for example, the very impressive Japanese effort to predict major earthquake in the Tokai region—again, Dr. Andrews may be speaking about this in his testimony—is something that we simply have not done in this country. It is one of the things that has stimulated, I think, the interest by many people in a prototype experiment here. Should we be doing something similar to the Japanese effort? That is a very expensive program and represents a much larger effort than we are currently undertaking.

Yes, there is no question but that in some areas there are foreign countries that are making a much larger effort than we are. I would not want to draw the conclusion, nevertheless, that means they are necessarily ahead of us in the understanding or the eventual prediction of earthquakes. However, certainly if they keep up their momentum and we lose ours, they will be.

Mr. Brown. In another area of technology, I have a vague understanding that we now have the capability of making precise geodetic measurements from space which enhance our ability to measure crustal movement and may give us a much better understanding of just what the dynamics of the Earth's surface are. Am I correct in this?

Dr. NUTTLI. I believe that is correct. The latest numbers I have heard are about a 3-centimeter or 1-inch accuracy in measurement over large distances.

Mr. BROWN. Using laser ranging——

Dr. NUTTLI. Satellite-based observations.

Dr. ALLEN. There is no question but the potential of that kind of observation is very, very great—for not only for understanding Earth dynamics, but even possibly for use in earthquake prediction. It is also very expensive.

Mr. BROWN. Do either of you gentlemen get involved in the matter involving the measurement of seismic phenomenon resulting from nuclear explosions underground?

Dr. NUTTLI. I do, yes, as part of my research effort.

Mr. BROWN. It has occurred to me that if we could get a good nuclear engineer here involved in the USGS or FEMA, we might be able to get better budgets for some of these programs.

Dr. NUTTLI. Perhaps so.

Mr. BROWN. Are there any further questions?

Do you have any questions, Mr. MacKay?

Mr. MACKAY. No, Mr. Chairman.

Mr. BROWN. All right. Thank you very much, gentlemen, for your testimony.

Our next panel is Dr. Richard Andrews, executive director of the California Seismic Safety Commission, and Dr. Charles Lindbergh from the Citadel, who is cochairman of the Southeastern U.S. Seismic Safety Consortium.

Do you want to start out, Dr. Andrews?

[The biographical sketch of Dr. Andrews follows:]

STATE OF CALIFORNIA
George Deukmejian, Governor

SEISMIC SAFETY COMMISSION
1900 K STREET, SUITE 100
SACRAMENTO, CALIFORNIA 95814-4186
(916) 322-4917

Richard Andrews
Executive Director

BIOGRAPHICAL SKETCH

RICHARD A. ANDREWS
Executive Director
California Seismic Safety Commission

Richard Andrews is Executive Director of the California Seismic Safety Commission. Prior to that appointment he served as Director of the Southern California Earthquake Preparedness Project, a state/federal effort to stimulate preparedness in southern California for predicted or unpredicted catastrophic earthquake.

Andrews has presented papers on earthquake prediction and public policy to the U.S. Geological Survey and the Seismological Society of America and has addressed a variety of audiences on earthquake prediction and preparedness issues. In October 1981 he was a member of a research team from the Southern California Earthquake Preparedness Project that reviewed current Japanese earthquake prediction and preparedness programs.

Andrews, a graduate of DePauw University, holds a Ph.D. from Northwestern University.

STATEMENT OF RICHARD ANDREWS, EXECUTIVE DIRECTOR, CALIFORNIA SEISMIC SAFETY COMMISSION

Dr. **Andrews**. All right.

Congressman Brown, members of the subcommittee, thank you for inviting me to testify.

The California Seismic Safety Commission is an independent public commission established in 1975 to advise the governor and legislature on earthquake safety policy. In addition to our core programs in policy development, implementation, and review, the commission is currently managing three new earthquake preparedness initiatives, including the Southern California earthquake preparedness project, or SCEPP, the State task force on earthquake preparedness, and the earthquake education project.

The commission is vitally interested in the subject of these hearings. Our interest is enhanced to the point of urgency by the unanimous scientific consensus that a major earthquake, perhaps of catastrophic proportions, is probable in California in the near future.

Since late 1980, when the most recent forecast for California became known through the publication of a Federal report, the State has allocated over $1.7 million in new support for earthquake preparedness.

The national earthquake hazards reduction program was undertaken because of the need for a coherent approach to earthquake safety. The intent was clearly hazard reduction, implying problem-centered research, the application of knowledge to lessening risk and protecting property, and direct action programs. The commission fully supports the intent of the national program.

We believe current funding is at a minimally acceptable level. Particularly when States such as California are facing extraordinary fiscal constraints, it is essential that funding levels be maintained and, where justified, enhanced.

Important progress has been made in this program. In gauging that progress, remember that funding levels originally envisioned generally have not been attained. In establishing future levels of support, recognize that many basic policy problems can only be answered by vigorous basic research in several disciplines.

The commission applauds the development of national 5-year plans and convening a review panel, and we support continued peer evaluation. Nevertheless, the commission has several concerns about the national earthquake program.

Existing knowledge about seismic phenomena, strong ground motion, and structural behavior justifies stronger measures than are now being taken. Much more needs to be done in interpreting and translating the findings of basic and applied research in ways that aid policy development and implementation. Greater attention should be given to the needs of State and local officials in defining research priorities.

Because of the very real threat we face in California, we feel a sense of urgency to apply research findings in time to aid current mitigation and preparedness efforts.

The things we construct propose the greatest threat to life safety during an earthquake. The long-term goal of California's seismic safety policies, therefore, is to reduce the State's vulnerability through mitigation programs.

Since the mid-1970's, California has appropriated between $14 and $18 million annually for earthquake safety-related programs. Four cities, including Los Angeles, have ordinances to strengthen unreinforced masonry structures.

State legislation recently gave permissive authority to local jurisdictions to participate in a $200 million bond program to help finance rehabilitation of old hazardous buildings. Strengthening existing structures is expensive, often beyond the resources of owners, and we have only begun to address the problem of hazardous structures statewide.

We should consider, the State of California and the Federal Government, cooperative funding for mitigation programs.

As mentioned, since the publication of the 1980 Federal report estimating probabilities, impacts, and levels of preparedness for a catastrophic California earthquake, the State has undertaken three initiatives to accelerate preparedness. One of these, SCEPP, is a State and federally funded effort.

SCEPP's approach has several important features. First, the project is working directly with local governments, private industry, and volunteer groups in a cooperative planning partnership. The SCEPP model, emphasizing development of local support for long-term mitigation and preparedness planning, represents a central departure from past practice.

The SCEPP and State task force experience in California suggests that when the threat is seen as real, guidance and technical assistance can motivate public agencies and the private sector to take preparedness planning seriously.

We estimate that inkind contributions to SCEPP and the task force since February 1981 from private industry and local government totals over $2 million. Current funding for SCEPP ends on June 30, 1983. The commission is seeking State support for an extension of the project into an application and dissemination phase. We believe cooperative State-Federal funding is highly desirable, but securing new money in California currently is very difficult.

Given the real threat in southern California, SCEPP's promising achievements, and the receptive climate in the region toward further preparedness efforts, this project represents, we believe, an unprecedented opportunity to realize the mandate of the national earthquake hazard reduction program.

Careful attention should be given to possible joint agency funding for specific aspects of the SCEPP effort.

In reviewing the national earthquake program, keep in mind, as has been mentioned earlier, that very few resources are now devoted to earthquake safety. For comparison, earthquake-conscious Japan allocates approximately $100 per citizen in seismic-prone areas. In California, taking into account State and Federal programs, we spend just over $1 per resident.

If history can predict, funds will flow immediately following the next earthquake disaster in California. Our challenge is to allocate resources intelligently in advance of the catastrophe, when we can reduce loss of life and property and minimize long-term economic disruption.

The California Seismic Safety Commission welcomes future discussions of strategies for insuring greater attention to earthquake safety.

Thank you.

[The prepared statement of Richard Andrews follows:]

TESTIMONY TO THE
HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

March 15, 1983

by

Richard Andrews, Ph.D.
Executive Director

State of California
SEISMIC SAFETY COMMISSION
1900 K Street, Suite 100
Sacramento, California 95814
(916) 322-4917

Chairman Walgren, members of the Subcommittee on Science Research and Technology, thank you for inviting me to testify before you today. I am Richard Andrews, Executive Director of the California Seismic Safety Commission. Prior to my appointment on October 1, 1982, I served as Director of SCEPP, the Southern California Earthquake Preparedness Project.

INTRODUCTION

The California Seismic Safety Commission (SSC) is an independent public Commission established in 1975 to advise the Governor and Legislature on earthquake safety policy. The SSC, composed of fifteen members appointed by the Governor plus a member from both the State Senate and Assembly, is responsible for: establishing goals and priorities in earthquake safety and preparedness, recommending needed program changes, gathering, analyzing and disseminating information, encouraging research, and helping to coordinate the earthquake safety activities of the private sector and government at all levels.

In addition to on-going programs in policy development, implementation and review, the SSC is currently managing $2,145,000 in contracts for new initiatives for earthquake preparedness, including SCEPP, the State Task Force on Earthquake Preparedness, and the Earthquake Education Project. $1,050,000 of these contracts are with funds allocated to FEMA through the National Earthquake Hazards Reduction Program (NEHRP).

Four members of the SSC, plus the Commission's only previous Executive Director, served on the Review Panel that recently completed an assessment of the proposed Five-Year Programs for the NEHRP. Karl Steinbrugge, first Chairman of the California Seismic Safety Commission, chaired the panel. In short, the SSC is vitally interested in the subject of these hearings and uniquely placed to offer perspectives on the NEHRP.

Our interest and concern is enhanced by the unanimous scientific consensus that a major earthquake, perhaps of catastrophic proportions, is probable in California in the near future. The forecasts are variously stated, including the "rough estimate" of "50-50" odds that a major earthquake will occur somewhere in California in this decade.[1] Such an event in one of California's metropolitan regions is likely to cause losses in the billions of dollars to property, sharp reduction in industrial capacity, and the possible loss of thousands of lives and even more casualties.

There have been approximately twenty damaging earthqakes in California in this century. California's first earthquake safety program was enacted in 1933. Since 1969, when the Joint Legislative Committee on Seismic Safety began its work, California has continuously emphasized seismic safety policy development and implementation. No other state, nor the Federal government, has such a record of accomplishment in earthquake safety. Since the mid-1970's California has allocated between $14 and $18 million annually to earthquake safety programs administered by 18 agencies. Since late 1980, when the most recent earthquake forecasts for California became widely known, the State has allocated $1,764,000 in new money to finance initiatives in earthquake preparedness planning and education.[2]

NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

The National Earthquake Hazards Reduction Program was undertaken because of the realization of the need for a coherent approach to earthquake hazard reduction. The intent of the legislation was clearly "hazard reduction," implying problem-centered research, the application of knowledge to lessening risks and protecting property, and direct action programs like SCEPP.[3]

The SSC fully supports the intent of the NEHRP. We believe that current funding represents a minimally acceptable level of support. Particularly when states with a high earthquake vulnerability like California are facing extraordinary fiscal constraints, it is vital that funding levels of the NEHRP be maintained and, where justified, enhanced.

Important progress has been made in this program. The U.S. Geological Survey and National Science Foundation, with knowledge producing and application responsibilities, have achieved significant results. For example, the understanding we have regarding recurrence intervals of major earthquakes along the south-central San Andreas is new knowledge, gained with research supported by this program. This information has had a significant impact on earthquake safety policy in California. In engineering, we know more about structural vulnerability and how to design to resist strong ground motion. Our understanding of human behavior in disasters, public attitudes toward preparedness, and policy development has been enlarged through research funded by the NEHRP.

In gauging progress in this program, it is well to keep in mind that funding levels envisioned in the Newmark-Stever report have not been generally attained. In establishing future funding levels, it is important to recognize that many important policy problems can only be answered by vigorous basic research. The capabilities of major faults in California's metropolitan areas are not equally understood.

The variation in shaking intensity from earthquakes is known only in broad ways. On the engineering side, the lack of recorded ground motion from the largest likely earthquakes remains a gap in improving structural design. The United States lags far behind other countries in the full scale testing of structures. These basic research problems each have important policy implications. It is important, therefore, that basic research continue vigorously and that funds be appropriated to support deployment of seismographic equipment and engineering testing facilities.

The SSC applauds the development of five-year plans and FEMA's convening of a review panel to assess the programs. We support continued peer evaluation and outside review. The USGS has completed a thoughtful, searching review and realignment of its programs. The National Science Foundation has been receptive to suggestions for ways to improve the dissemination and application of research findings.

Nevertheless, the SSC has several concerns about the NEHRP. Existing knowledge about seismic phenomena, strong ground motion, and structural behavior justifies stronger measures than are now being taken. The results of research embodied in numerous individual studies needs to be more effectively interpreted, summarized, disseminated and applied. In testimony given to this committee in previous years, witnesses have identified the need to disseminate research findings more effectively. This remains a problem. Dissemination through professional journals alone is not sufficient. Reports should be required for all research projects funded through the NEHRP, and Summaries of the findings should be disseminated in a single volume rather than scattered in diverse journals.

Much more needs to be done in policy research, interpreting and translating the findings of basic and applied research in ways that will guide policy development. Important kinds of exploration are needed which are not typically referred to as research. These include interpreting the significance of research findings, developing workable policies to deal with problems identified and formulating strategies for effective policy implementation.

Another SSC concern is the process by which research awards are granted. Because agency choices are largely dependent upon the focus of proposals submitted, research sometimes lacks any identifiable sense of direction. Academic researchers essentially respond to the logic of their own disciplines, rather than the needs of policy makers. This is understandable and defensible, even necessary, up to a point. On the other hand, there is legitimate concern about the balance and coverage of the program. Greater effort needs to be given to ensuring that the needs of policy and preparedness officials at the state and local levels are taken into account. We encourage USGS and NSF to work directly with state and local officials in determining research priorities. The agencies should undertake jointly funded efforts to support action programs like SCEPP, which provide a special opportunity to fulfill the intention of the NEHRP by applying research findings at the local level. While there are administrative barriers to overcome in achieving cooperative funding, we believe such a strategy is clearly within the intent of the NEHRP, and that important advances can be made.

To address these and other topics the SSC recently established a committee on research. The Committee's goal is to focus on defining research needs and other policy investigations that are likely to help California improve its seismic safety efforts. The Committee will review research underway and define high priority research needs for SSC review. The SSC is keenly interested in providing advice to the research community on the types of studies needed for policy development and implementation. Because of the very real threat we face in California we feel a sense of urgency to apply and disseminate research findings in time to aid our current preparedness and mitigation efforts.

CALIFORNIA'S SEISMIC SAFETY POLICIES

The scientific consensus about the near-term likelihood of a major earthquake in California has added new urgency to our on-going efforts in seismic safety policy development. The things we construct--buildings, utility systems, transportation and communications networks--pose the greatest threat to life safety. The principal goal of California's programs, therefore, is to reduce the State's vulnerability through research to understand and identify the hazards more precisely and mitigation programs.

Since the establishment of the SSC in 1975 a number of new programs have been added to the State's seismic safety efforts. For example, the SSC helped draft and support legislation authorizing local governments to establish special standards for hazardous building rehabilitation. Four cities in California, including Los Angeles, have enacted ordinancies to strengthen old, unreinforced masonry structures. Legislation approved in 1982 gave permissive authority to local jurisdictions to participate in a $200,000,000 bonding program to help finance rehabilitation of old hazardous buildings. This is an important measure, though the SSC estimates that up to $500,000,000 may be needed to address this problem.

California has a solid record of achievement in seismic safety policy development and implementation, but many important problems remain. For example, a soon-to-be-released SSC report, The Construction Process: Quality Control, Inspection and Performance concludes that inadequate on-site inspection and pressures to reduce costs frequently results in new buildings unnecessarily becoming part of the inventory of hazardous structures. A second report, still in draft, concludes that some classes of newer buildings--non-ductile reinforced concrete buildings, tilt-up structures, "soft-story" buildings, some structures with prestressed concrete elements--must be considered potentially hazardous.

These conclusions further complicate a fundamental problem of developing effective strategies and policies for the long-term financial and political support of earthquake safety. Efforts to strengthen existing structures are expensive, often beyond the resources of building owners. Moreover, there is significant variation in the quality of local enforcement of building codes and monitoring of on-site construction. Smaller jurisdictions frequently lack the professional expertise needed to enforce existing policies effectively; strategies must be developed to provide greater technical assistance to local jurisdictions.

Two major reports published in 1982 by the California Division of Mines and Geology outline probable impacts to the major lifeline systems from 8.3 earthquakes in southern or northern California. These reports point out that our metropolitan centers are vulnerable to widespread sustained interruption of electrical, water, sewage, natural gas, and communications networks after large magnitude earthquakes. The SSC is currently assessing possible approaches to this problem. The SSC has long supported the principle that all new critical facilities and utility lifelines should be subject to thorough, independent review and inspection of design and construction. The SSC is also exploring possible legislation to establish seismic standards for emergency services structures--police, fire, emergency command and communication facilities. Except for hospitals these structures are not subject to review with respect to their seismic resistance.

Even this brief listing of some current issues underscores the central importance of mitigation programs to our efforts in seismic safety. Such programs are expensive and ways must be found to develop cooperative approaches in which federal funds are added to the already substantial state and local commitment to reducing our earthquake vulnerability. Again, given the scale of the problems we face, with losses projected as high as $17,000,000,000 from the most probable major San Andreas earthquake, much greater commitment of resources is justified.

SCEPP AND RECENT INITIATIVES

Since the publication of the FEMA, National Security Council Report An Assessment of the Consequences and Preparations for a Catastrophic California Earthquake: Findings and Actions Taken, California has undertaken three new initiatives to accelerate preparedness: SCEPP (Southern California Earthquake Preparedness Project), State Task Force on Earthquake Preparedness and the Earthquake Education Project. As mentioned earlier, the State has allocated $1,514,000 to these programs, with an additional $250,000 designated for the Earthquake Education Project for the 1983-84 fiscal year in Governor George Deukmejian's proposed budget. Moreover, the SSC is requesting that an additional $430,000 be added to our budget to support a continuation of the SCEPP and Task Force initiatives.

SCEPP is a state and federally funded effort to stimulate preparedness for predicted or unpredicted catastrophic earthquakes in the Los Angeles metropolitan area. The Project's current funding runs out on June 30, 1983. FEMA Region IX has indicated their intention to support the project through September 1984. Negotiations regarding this proposed extension are only in the initial stage.

SCEPP operates under the executive authority of the Seismic Safety Commission through a cooperative agreement with the Federal Emergency Management Agency, Region IX. A 21 person Policy Advisory Board oversees SCEPP's activities and provides outreach to the professional, governmental and volunteer communities in southern California. We estimate that approximately $750,000 of in-kind contributions have been provided by representatives from the private sector, local government and volunteer agencies to support SCEPP activities.

The Project is addressing a broad range of issues related to preparedness planning, including outlines of a warning system to be used in the event of a short-term earthquake prediction, neighborhood and school preparedness programs, public information materials, and a model earthquake loss-projection capability to aid preparedness planning and emergency response.

SCEPP's approach has several important new features. First, the project is working directly with local governments, private industry and volunteer groups in a co-operative planning effort. Through the Project's planning partnerships elected officials, city and emergency planners, building officials, transportation and utility representatives, the media, school and neighborhood groups, and private sector representatives have been brought into a common planning process. Too frequently preparedness planning has been viewed as the responsibility of a single agency. For the most disasters such an approach is adequate. But given the projected impacts of a large magnitude earthquake striking a metropolitan area, it is necessary to involve a broad range of governmental agencies, the private sector, the media and neighborhood groups in the planning. SCEPP has achieved significant success in providing a link between such groups.

Second, the SCEPP approach to preparedness planning is comprehensive. That is, the Project is addressing the full range of earthquake safety strategies including mitigation, short-term prediction response, emergency response and recovery. For example, the prototype plans developed by SCEPP and the County of San Bernardino are structured around four time periods: long-term response plans (essentially mitigation programs and public awareness efforts), actions to be taken in response to a short-term warning of an expected earthquake, emergency response in the first 72 hours after a major earthquake, and guidelines for recovery in the first month after the event. The Project also is developing a neighborhood preparedness program, utilizing the Neighborhood Watch programs. It also has developed a model earthquake preparedness curriculum for the County school district.

The SCEPP model, emphasizing development of local support for long-term mitigation and preparedness planning, represents the central departure from past practice in preparedness efforts. The SCEPP experience suggests that with proper guidance and technical assistance a broad range of public agencies and the private sector can be brought into the planning process. The next challenge is to build on the SCEPP model and professional expertise. We need to apply the prototype plans developed by SCEPP through its planning partnerships, first disseminating the plans in southern California and then to other high risk metropolitan regions.

Further attention needs to be given to promoting comprehensive regional planning, to coordination of preparedness by public and private sector groups.

Through this research and development phase of SCEPP, the Project has been jointly supported by the State of California and FEMA. We believe such a cooperative funding strategy is highly desirable. However, as is well known, the State of California is facing extraordinary fiscal constraints at the present time, making it difficult to secure new funding. FEMA Region IX has clearly indicated their intention to support a 15 month extension of SCEPP even without state funds. I am, however, concerned that funds being earmarked for SCEPP by FEMA will not be adequate to accomplish the application and dissemination of the Project's prototype plans and public awareness materials. The SCEPP staff and Policy Advisory Board estimate that approximately $830,000 would be needed to support a 15 month extension.

Given the very real threat we face in southern California, the promising achievements of SCEPP to date, and the receptive climate in the region toward further preparedness efforts, I urge FEMA to consider allocating greater resources to finance a continuation of the Project. In addition, careful attention should be given to providing funding from USGS and the National Science Foundation to support SCEPP activities, particularly in expanding the areas of hazard mapping and data base development as well as coordinating the possible deployment of an operational earthquake prediction system with the warning mechanisms outlined in a forthcoming SCEPP report. The National Science Foundation should consider having researchers work closely with the SCEPP staff to strengthen ties between research and application at the local level. In short, the SCEPP effort represents an unprecedented opportunity to realize the mandate of the NEHRP for problem centered research and direct action programs.

In addition to SCEPP, a State Task Force has operated for the past two years, drawing together over 200 representatives of the private sector to work with state agency officials in making recommendations on how to respond in the first 72 hours following a major earthquake in northern or southern California. Working with the State Office of Emergency Services, the Task Force has assisted in developing a new generation of earthquake annexes to the state emergency plan.

The Task Force operates on three assumptions: (1) major earthqukes are inevitable in California, (2) because of the size of the expected disasters government will be unable to provide all the assistance needed in the most heavily damaged areas for up to 72 hours after the event, and (3) worksite, neighborhood, and family preparedness planning is essential to improving emergency response.

In addition to specific recommendations for future actions, the Task Force has helped create the beginnings of a vocal constituency for earthquake safety that extends beyond the scientific and engineering communities, which have formed the traditional core of advocates for seismic safety. The Task Force represents an impressive example of government/private sector cooperation in addressing a serious problem of common interest to the entire community.

A third recent initiative in California is the Earthquake Education Project. Through monies from the Environmental License Plate Fund, $500,000 has been provided to the Seismic Safety Commission to contract with Lawrence Hall of Science, University of California, Berkeley, to develop and test earthquake education materials for individuals and community organizations over a two-year period. The Lawrence Hall of Science has extensive experience in developing innovative approaches to science education. The goal of this effort is to increase understanding and awareness of earthquakes and their impacts so as to motivate the public to adopt local programs to minimize property damage and personal injury. CALEEP is developing easily transportable, self contained exhibits to introduce the causes, nature, and effects of earthquakes. After pilot testing in Alameda, Contra Costa and Los Angeles counties the materials will be made available statewide.

CONCLUSION

The initiatives undertaken by the Seismic Safety Commission, SCEPP and the State Task Force demonstrate that local and private sector support for preparedness efforts can be created. It is important to keep in mind that while these activities hold great promise for better preparedness, very few resources are now being devoted to earthquake safety at the state or federal level. For comparison, earthquake-conscious Japan allocates approximately $100 per citizen to earthquake safety; in California, taking into account both state and federal programs, we spend roughly $1.00 per resident. There are legitimate reasons for this disparity. The essential point, however, is that given the scale of the problem and the estimated losses from a major California earthquake, at some point greater resources must be directed toward earthquake safety.

A forthcoming SSC report, Earthquake Hazards Management: An Action Plan For California, calls for expenditure of over $700,000,000 over five years in earthquake safety, with $500,000,000 being for a state and bond issue to underwrite rehabilitation of old hazardous buildings. Other needs identified are a major program of tests and exercises and a $20,000,000 initiative to upgrade emergency capabilities, including regional earthquake resistant command centers, better voice and video communications, and a management information system for estimating losses, assessing damage and allocating resources. Federal support for such program is essential.

If history can predict, funds will no doubt flow immediately following the next earthquake disaster in California. Our challenge is to allocate resources intelligently now, in advance of the catastrophy, when we can significantly reduce loss of life and property as well as minimize long-term economic disruption. The California Seismic Safety Commission welcomes future discussion of strategies for ensuring ever greater attention to earthquake safety efforts.

In closing, let me reiterate the SSC's strong support of the intent of the NEHRP. We believe there are no "quick fix" solutions in earthquake safety. We must continue seismological research to understand earthquakes more thoroughly, engineering studies to improve building design, and policy analysis to guide our actions. We must accelerate efforts to upgrade existing buildings and lifeline systems as well as monitor new construction more rigorously. We must improve our emergency response capabilities while avoiding a narrow focus on disaster response. We should enhance government's capability to respond to disasters while promoting private sector, neighborhood and self-help preparedness programs. Our strategy, like that of the Tokyo Metropolitan Government, should be to attack the disaster, not merely escape it. Disaster management is not enough; disaster prevention should be the goal.

NOTES

1. Bruce A. Bolt and Richard H. Jahns, "California's Earthquake Hazard: A Reassessment," *Public Affairs Report*, 20 (4), August 1979.

2. RECENT CALIFORNIA APPROPRIATIONS FOR EARTHQUAKE SAFETY INITIATIVES

SCEPP (AB 2202)		$ 750,000
Governor's Task Force (FY 81-82)		319,000
State Task Force (FY 82-83)		195,000
Earthquake Education Project (FY 82-83)		250,000
Earthquake Education Project (Proposed FY 83-84)		250,000
		$1,764,000
SCEPP Extension (Proposed by SSC for FY 83-84)	$300,000	
Task Force Extension (Proposed by SSC for FY 83-84)	130,000	
	$430,000	
TOTAL ALLOCATED AND PROPOSED - - - - -		$2,194,000

3. This testimony draws upon several recent documents prepared by the Seismic Safety Commission, including: *Earthquake Hazards Management: An Action Plan for California* (82-01), forthcoming; *The Commission's Role in Research* (February 1983); Richard Andrews, "Testimony to the Joint Legislative Committee on Fire, Police, Emergency and Disaster Services," (November 21. 1982); Richard Andrews, "Responses in California to Earthquake Forecasts", paper prepared for Los Angeles International Earthquake Conference (February 1983).

Mr. **Brown**. That is a very impressive statement, Dr. Andrews. You skipped over that part about recommending $700 million over 5 years in earthquake safety.

Dr. **Andrews**. That is in a forthcoming report; that's right.

Mr. **Brown**. A forthcoming report, all right.

Dr. **Andrews**. $500 million of that, though, is for a bonding program.

Mr. **Brown**. Dr. Lindbergh.

STATEMENT OF CHARLES LINDBERGH, HEAD, DEPARTMENT OF CIVIL ENGINEERING, THE CITADEL, CHARLESTON, S.C.

Dr. **Lindbergh**. Thank you, Mr. Chairman and other distinguished members of the subcommittee.

It is a privilege and a pleasure for me to be here speaking on behalf of our public in the Southeastern United States.

I have brought with me a written record but, with your permission, sir, I would like to stand and present from the screen.

Mr. **Brown**. Fine. The full text of your statement will be in the record, of course.

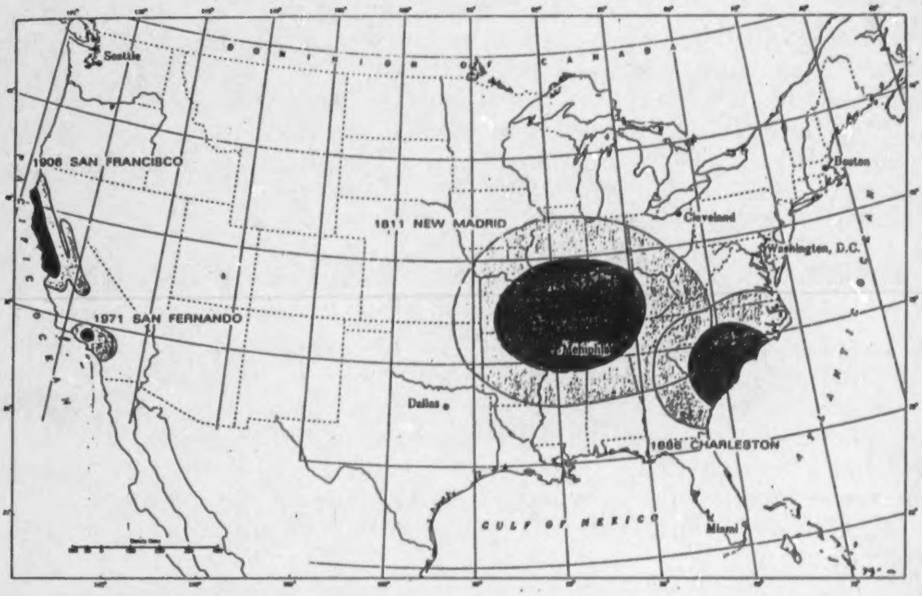
SOME VIEWS ON
THE NATIONAL EARTHQUAKE PROGRAM
AND THE SOUTHEASTERN UNITED STATES

presented to

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, D.C.

Slide 1

[The following remarks were made by Dr. Lindbergh while presenting slides:]


Seattle
DOMINION OF CANADA
1906 SAN FRANCISCO
1811 NEW MADRID
1971 SAN FERNANDO
Cleveland
Boston
Washington, D.C.
Memphis
Dallas
1886 CHARLESTON
GULF OF MEXICO
Miami
PACIFIC OCEAN
ATLANTIC OCEAN

SLIDE 2

Dr. LINDBERGH. I think that when summarized for us there are two distinctive differences between western and eastern earthquakes, one of which is frequency of occurrence, of course. Those in the west occur at a much greater frequency.

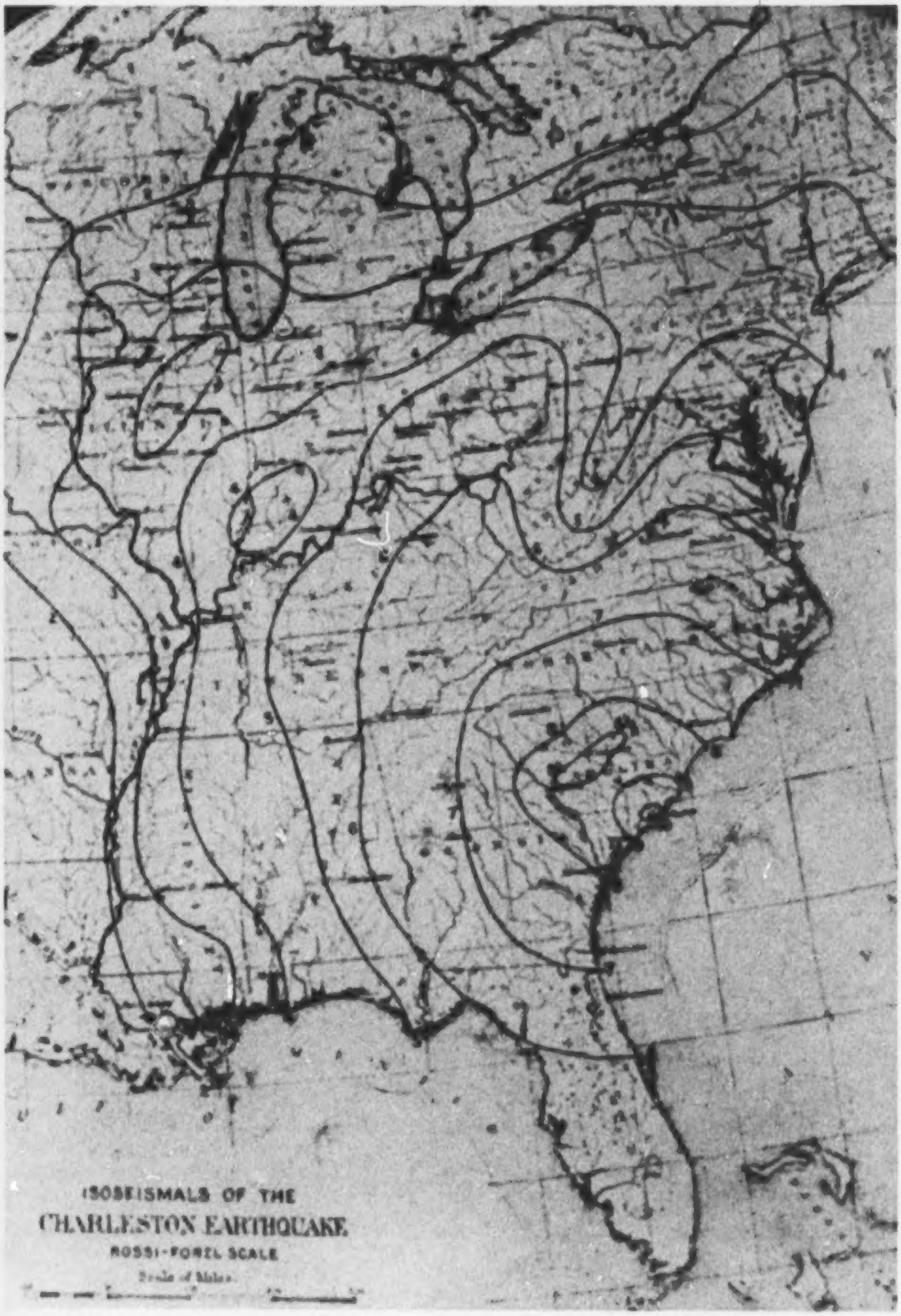
However, another major difference that is very key to our program in the East is that when the great or major earthquakes do occur in the east, the effects are more widely effective or ranged than their counterparts are in the West.

For example, we show the earthquake at Madrid in Missouri, 1811–12, and then more recently the 1886 earthquake in Charleston, S.C., just for relative comparison purposes.

Compare this earthquake [pointing to one on the west coast] with this one in Charleston. In the lightly shaded outline we see the range at which facilities would be slightly damaged, whereas in the darker zones we see evidence of the heavy or structural earthquake damage. The bottom line is that, in our viewpoint, whereas earthquakes occur more frequently in the West, those that occur in the east of the same magnitude and intensity are far more ranging in extent of damage.

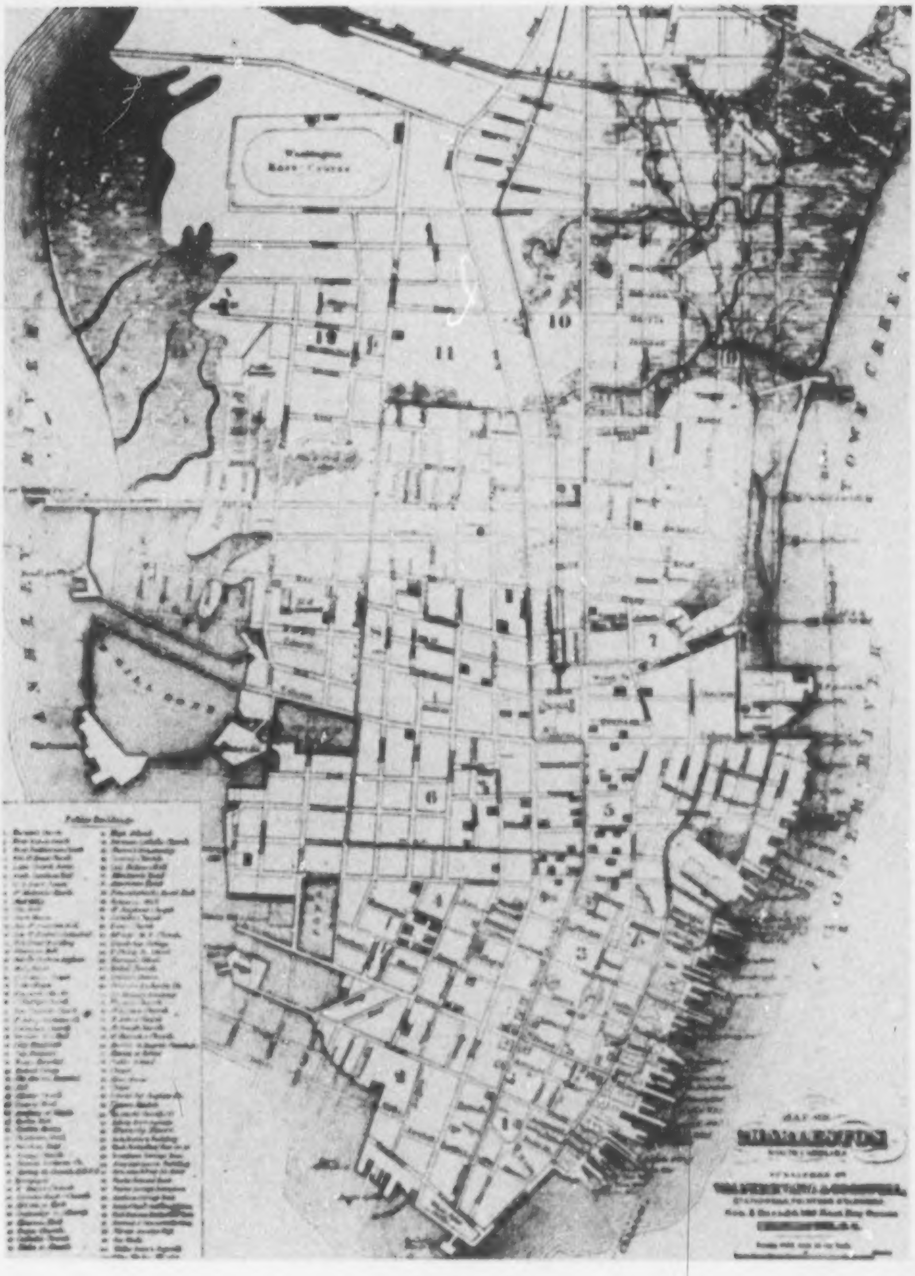
In the main, sir, when we look beyond the 4- or 5-year period to maybe less than a generation, we see that perhaps the eastern area is on par with that of our western counterparts.

I would like to share with you a little step back in time to Charleston, 1886.


ISOSEISMALS OF THE
CHARLESTON EARTHQUAKE
ROSSI-FOREL SCALE
Scale of Miles

SLIDE 3

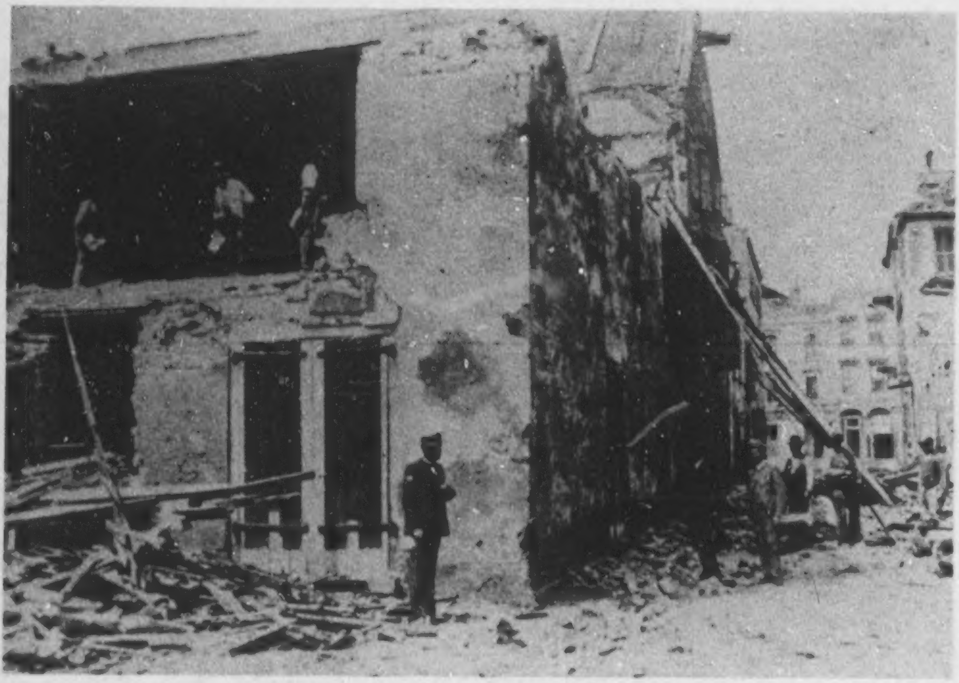
These are the isoseismals with which we are very familiar, describing the event that centered in Charleston and affected facilities as far away as Chicago and were noted up in Canada.



SLIDE 4

Instead of looking at isoseismals, I would like to take you through the community of Charleston depicting some of the actual damage that occurred there.

[The following historical slides (5–25) are from the Charleston City Museum.]



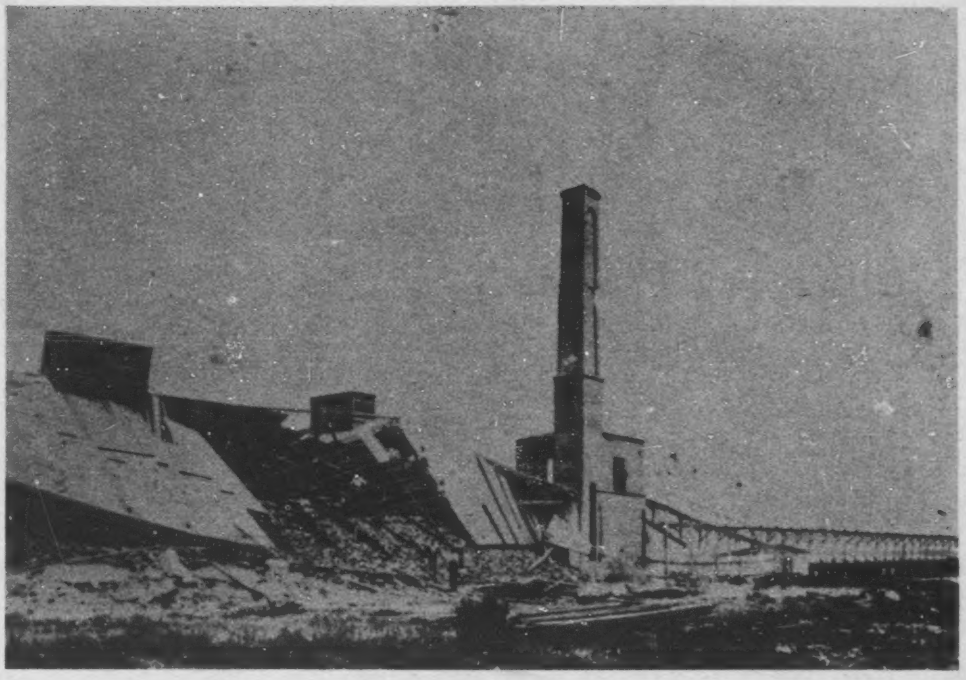
SLIDE 5

SLIDE 6

CIGARS & TOBACCO.
W. W. SMITH.

SLIDE 7

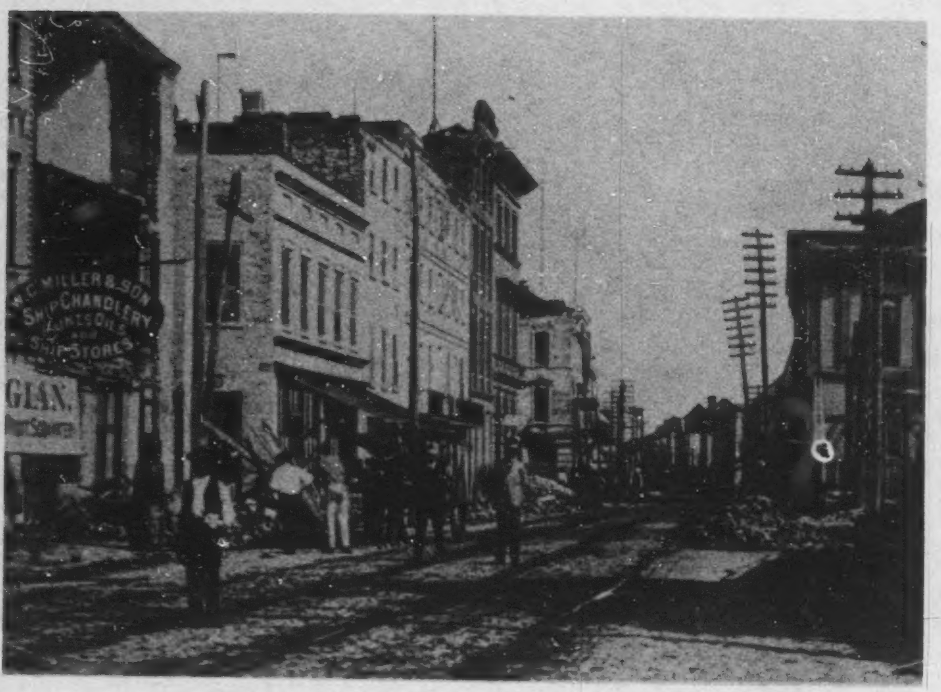
SLIDE 8



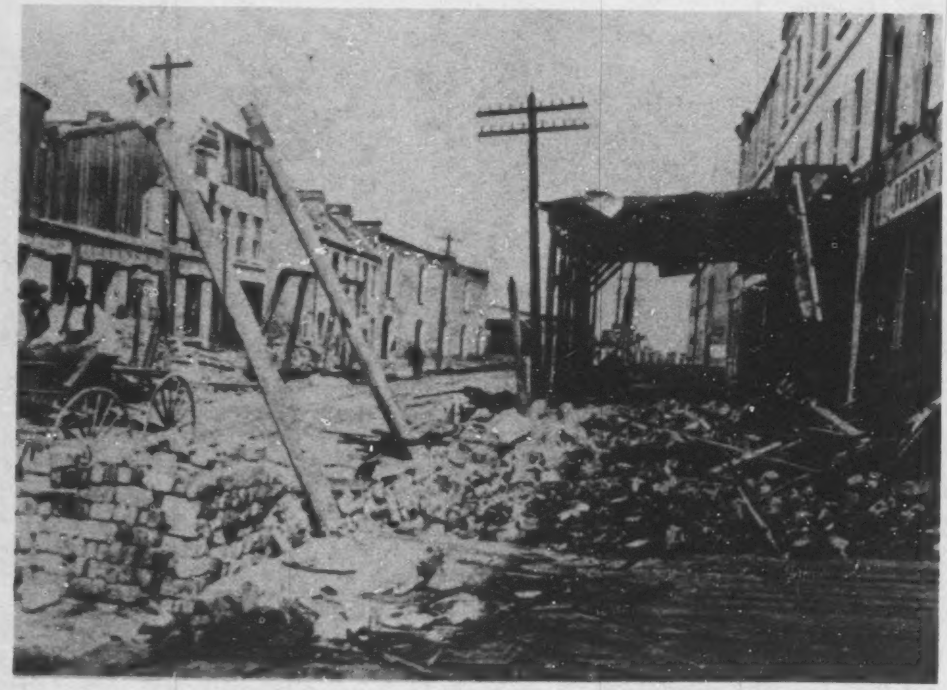
SLIDE 9

These are largely unreinforced masonary buildings common to Los Angeles and still found in the Charleston area.

The magnitude of this earthquake was 10.


MILLER & SON
SHIP CHANDLERY
AND
SHIP STORES
GLAN.

SLIDE 10

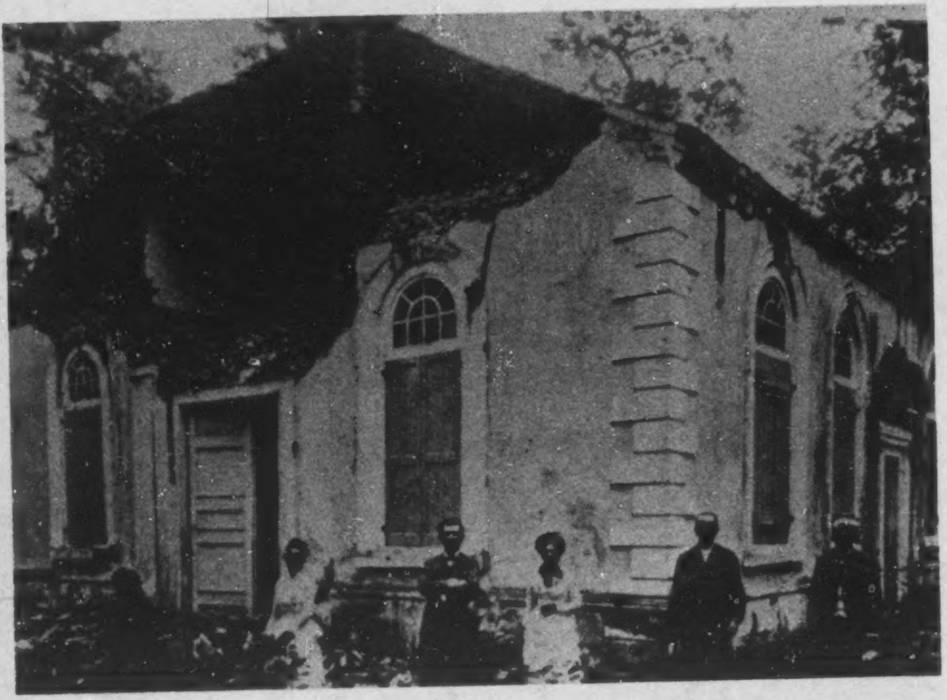


SLIDE 11

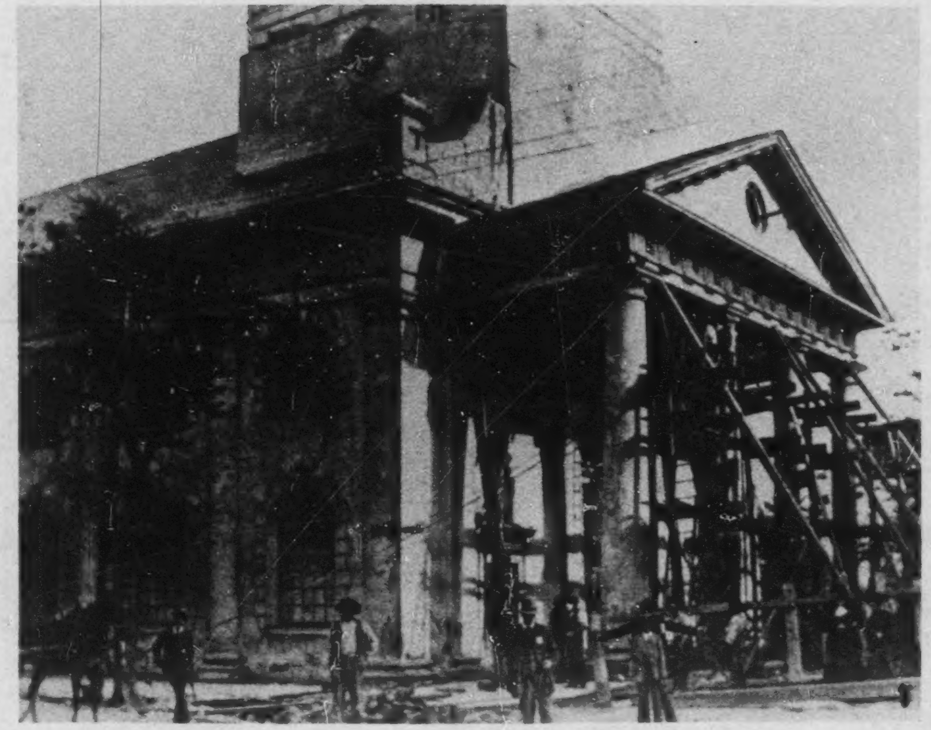
SLIDE 12

SLIDE 13

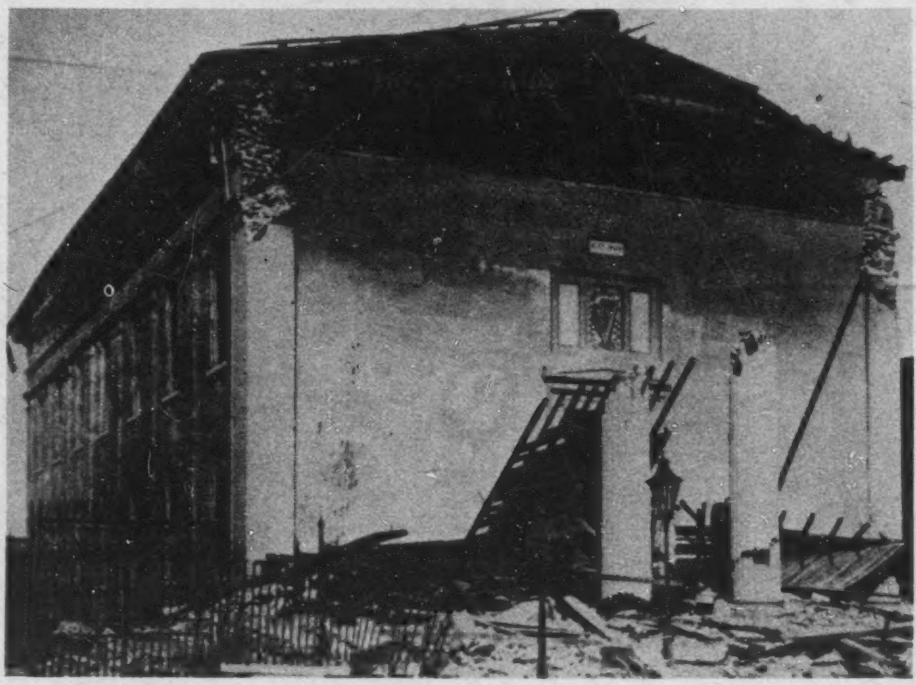
Slide 14



Slide 15

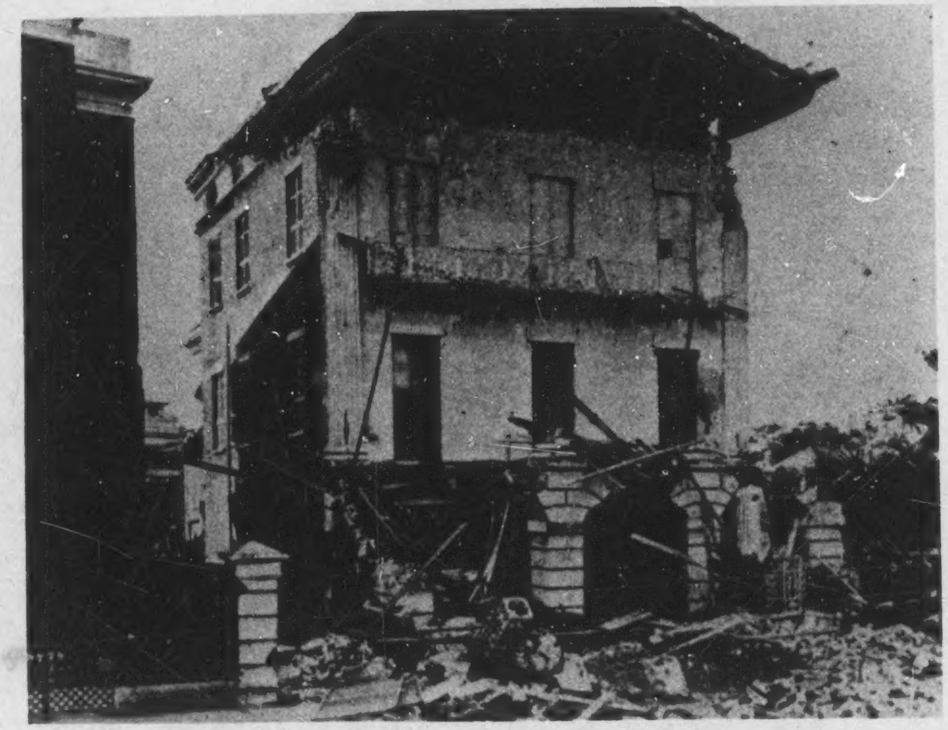


SLIDE 16



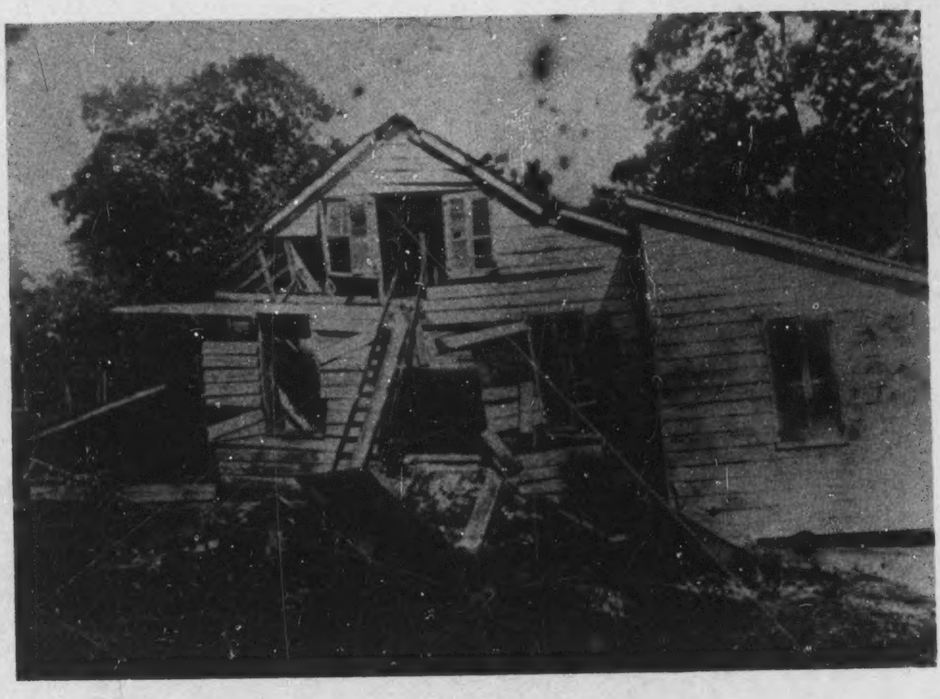
SLIDE 17

SLIDE 18

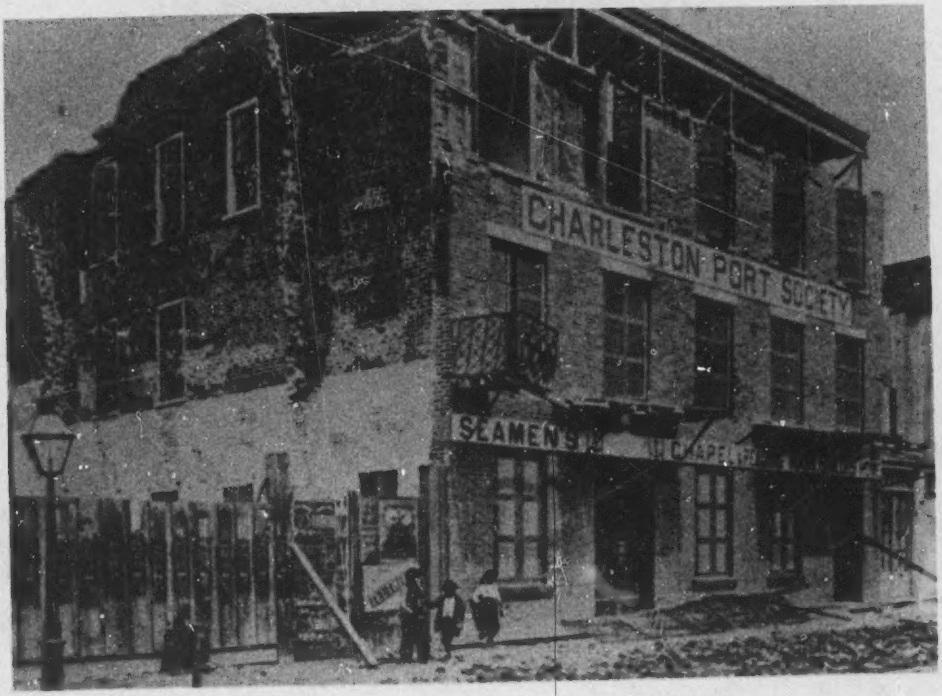


Slide 19

Slide 20



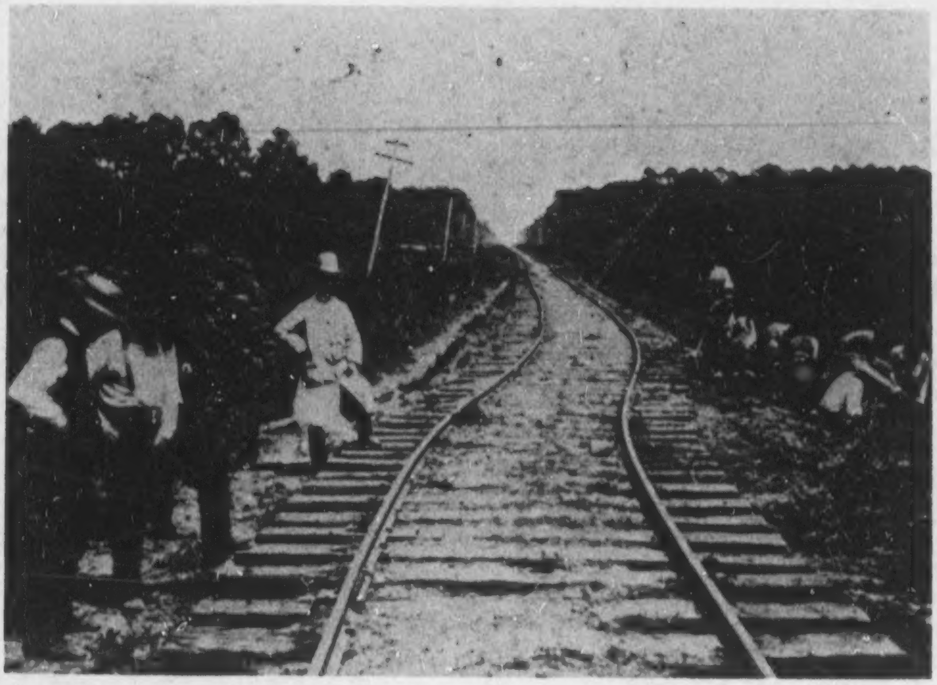
SLIDE 21


CHARLESTON PORT SOCIETY
SEAMEN'S
CHAPEL

SLIDE 22

SLIDE 23

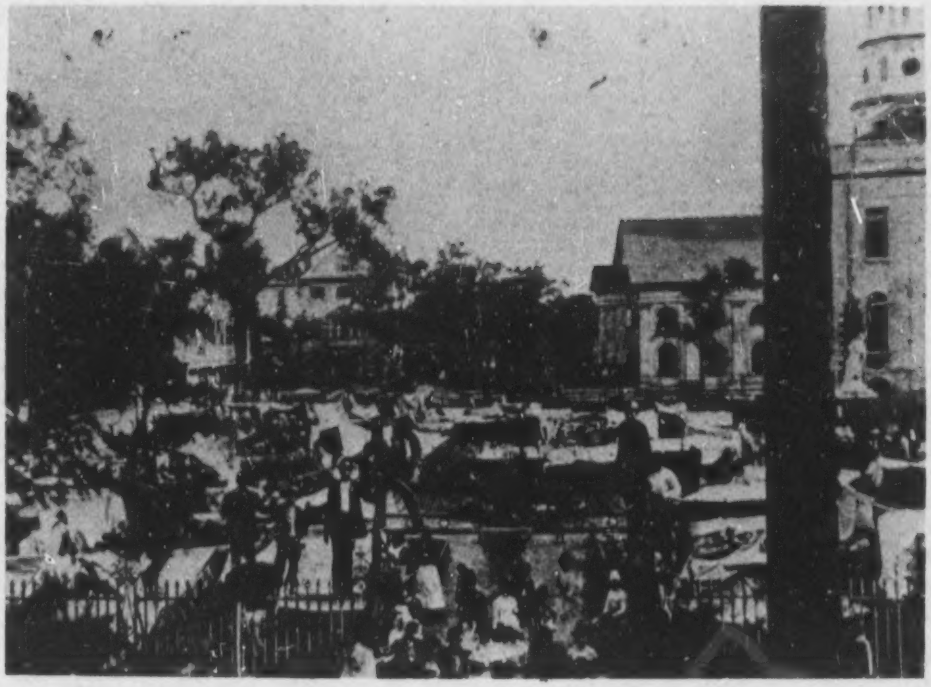
This is before the earthquake; this is after the disturbance.



SLIDE 24

You may ask if there were any railroad locomotives out that night when it occurred, and we have reason to believe there was at least one.

[Slide of a completely overturned locomotion shown.]



SLIDE 25

This is the refugee center that was set up in the city.

These, sir, are greatly in our minds. Even though we have not had heavy recent ones, we have had damaging ones before.

SEISMIC SAFETY NEEDS IN

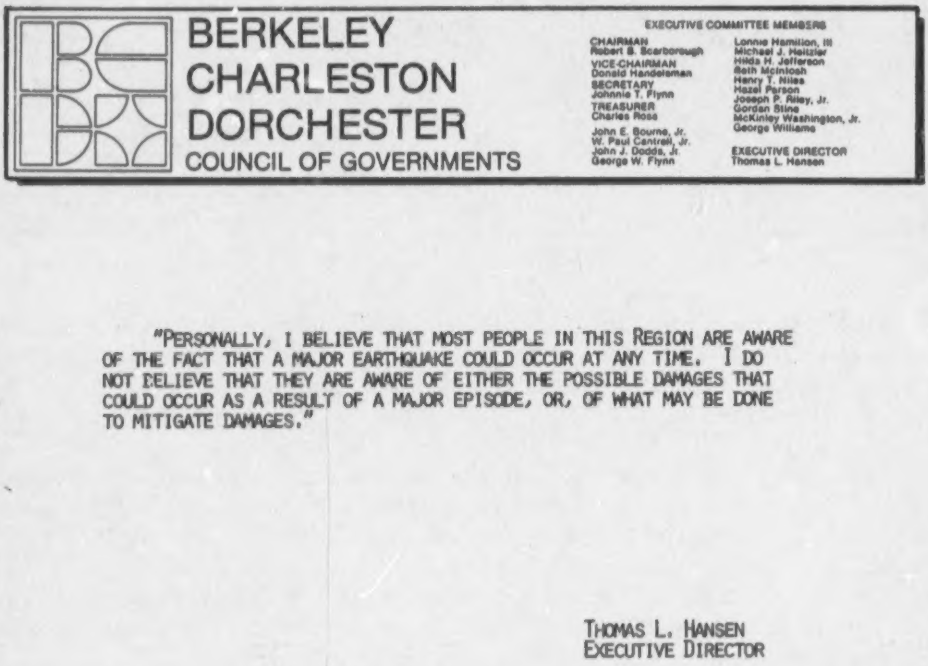
THE SOUTHEASTERN UNITED STATES

- INCREASED TECHNICAL KNOWLEDGE AND CAPABILITY
- ACHIEVEMENT OF PUBLIC POLICY

SLIDE 26

Our needs in the Southeastern United States are twofold. Our counterparts in the Western United States, as we understand, have developed significant technological base and awareness among the citizens and, hence, as they continue to improve or increase their technical knowledge, are achieving public policy acceptance. However, in the Southeastern United States this is quite different.

In short, our position is that of the Western States, including California, several decades ago. We must establish an increased technical knowledge base not only among our engineers and educators, but among our housewives and community members in general. Only then can we expect to achieve the very vital public policy throughout the Southeastern United States that is necessary.



BERKELEY
CHARLESTON
DORCHESTER
COUNCIL OF GOVERNMENTS

EXECUTIVE COMMITTEE MEMBERS

CHAIRMAN
Robert B. Scarborough
VICE-CHAIRMAN
Donald Handelsman
SECRETARY
Johnnie T. Flynn
TREASURER
Charles Rose

John E. Bourne, Jr.
W. Paul Cantrell, Jr.
John J. Dodds, Jr.
George W. Flynn

Lonnie Hamilton, III
Michael J. Heitzler
Hilda H. Jefferson
Beth McIntosh
Henry T. Niles
Hazel Parson
Joseph P. Riley, Jr.
Gordon Stine
McKinley Washington, Jr.
George Williams

EXECUTIVE DIRECTOR
Thomas L. Hansen

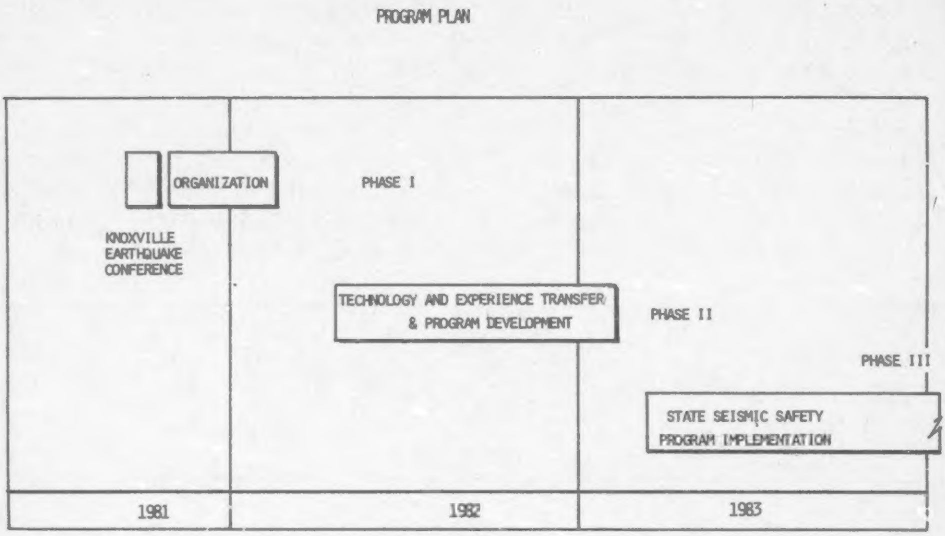
"PERSONALLY, I BELIEVE THAT MOST PEOPLE IN THIS REGION ARE AWARE OF THE FACT THAT A MAJOR EARTHQUAKE COULD OCCUR AT ANY TIME. I DO NOT BELIEVE THAT THEY ARE AWARE OF EITHER THE POSSIBLE DAMAGES THAT COULD OCCUR AS A RESULT OF A MAJOR EPISODE, OR, OF WHAT MAY BE DONE TO MITIGATE DAMAGES."

THOMAS L. HANSEN
EXECUTIVE DIRECTOR

SLIDE 27

This is really brought into focus very well by Mr. Hansen in Charleston, S.C., when he said, "Personally, I do believe that most people in this region are aware of the fact that a major earthquake could occur at any time. I do not believe that they are aware of either the possible damages that could occur as a result of a major episode or what may be done to mitigate damages." (Mr. Hansen is the executive director, Council of Governments, Dorchester-Berkeley-Charleston counties).

That, in my view, sir, more or less typifies the status in the Southeastern United States.



PROGRAM PLAN

ORGANIZATION

PHASE I

KNOXVILLE
EARTHQUAKE
CONFERENCE

TECHNOLOGY AND EXPERIENCE TRANSFER
& PROGRAM DEVELOPMENT

PHASE II

PHASE III

STATE SEISMIC SAFETY
PROGRAM IMPLEMENTATION

1981

1982

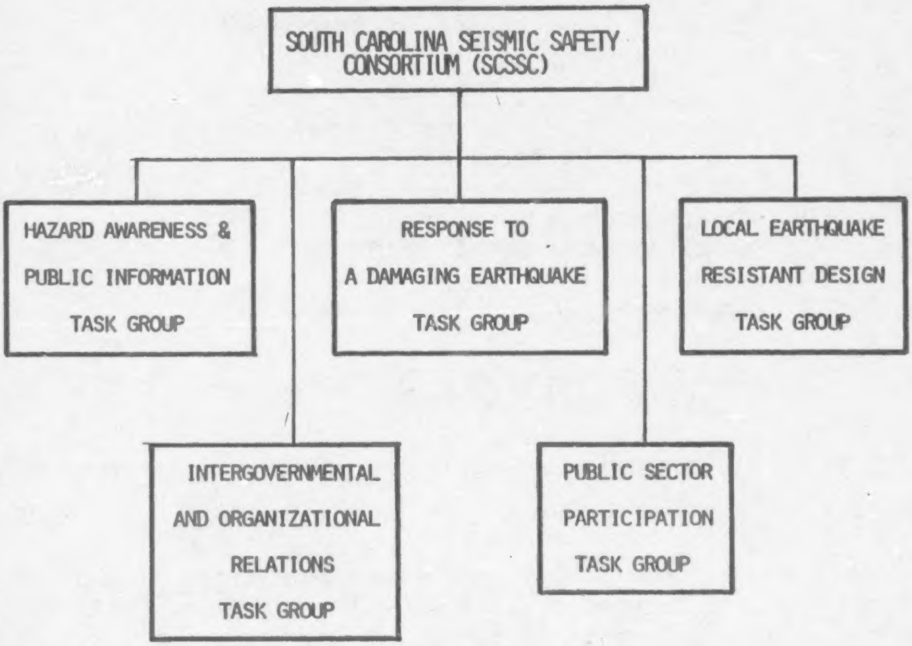
1983

Slide 28

Our program was launched with a Knoxville conference, a national engineering conference on earthquakes in the East, sponsored collectively by the USGS, the National Science Foundation, and others. We have since organized our southeastern seismic safety group.

We are in a phase of transferring technology and experience from our western coast counterparts. We have been fortunate enough to have the associations of our California representatives and Utah representatives, et cetera.

Of course, all that is aimed at giving us a fairly good start on developing a 5-year seismic safety improvement program in the Southeast.



SOUTH CAROLINA SEISMIC SAFETY CONSORTIUM (SCSSC)

HAZARD AWARENESS & PUBLIC INFORMATION TASK GROUP

RESPONSE TO A DAMAGING EARTHQUAKE TASK GROUP

LOCAL EARTHQUAKE RESISTANT DESIGN TASK GROUP

INTERGOVERNMENTAL AND ORGANIZATIONAL RELATIONS TASK GROUP

PUBLIC SECTOR PARTICIPATION TASK GROUP

SLIDE 29

Our Seismic Safety Consortium in the Southeastern United States is intended to be underpinned by strong State programs. South Carolina is our lead prototype organization. It is in full swing now.

These are certain members of our consortium, indicating the various States in the Southeast represented.

The organization of our Southeastern Seismic Safety Consortium is shown here.

Touching, the different aspects involved in seismic safety—the technical, the political, and the economic.

Our objectives are to implement a comprehensive State seismic policy but, most importantly, to develop the synergism and technical qualification among our regional technical, government, and public communities. Remember, we are back several decades.

We need to satisfy our technical needs by interface and by new technology development.

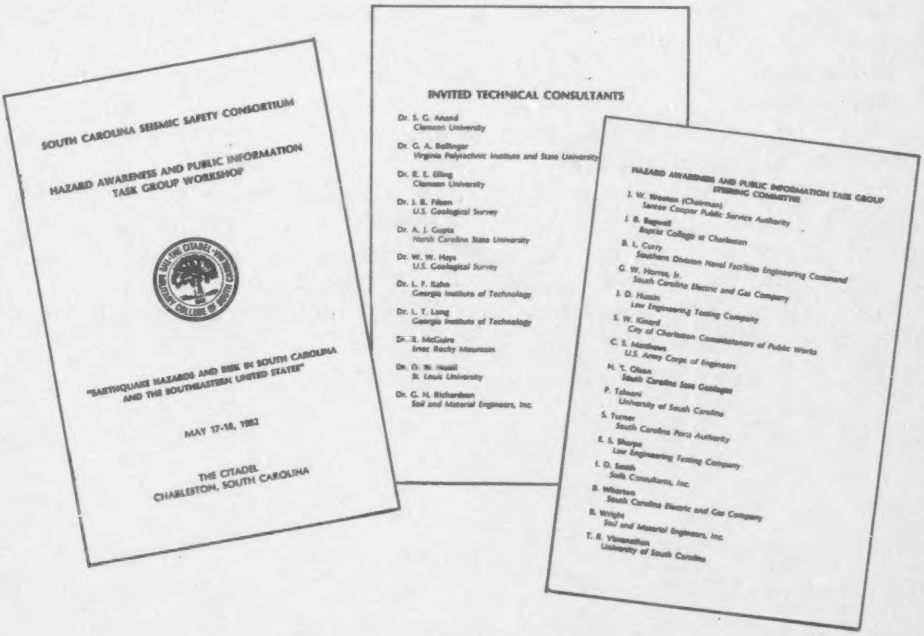
TECHNOLOGY AND EXPERIENCE TRANSFER PROGRAM

SESSION 1	EARTHQUAKE HAZARDS AND RISK IN SOUTH CAROLINA AND THE SOUTHEASTERN UNITED STATES
SESSION 2	SEISMIC SAFETY PLANNING STRATEGIES: LESSONS FROM UTAH AND CALIFORNIA
SESSION 3	EARTHQUKE RESISTANT DESIGNS CONSIDERATIONS
SESSION 4	SEISMIC SAFETY PLANNING STRATEGIES: LESSONS FROM MASSACHUSETTS
SESSION 5	THE GOVERNMENTAL VIEWPOINT ON SOUTH CAROLINA SEISMIC SAFETY

Slide 30

These are the lessons involved in our technology transfer program. We have completed our seismic threat assessment, which now gives us a common seismic threat status within the Southeastern United States. We have had visits by our Utah and California neighbors, helping us to transfer technology. We are now pressing on with our program to further transfer technology to our local communities.

[Slide shows conference program.]



SOUTH CAROLINA SEISMIC SAFETY CONSORTIUM

HAZARD AWARENESS AND PUBLIC INFORMATION
TASK GROUP WORKSHOP

"EARTHQUAKE HAZARDS AND RISK IN SOUTH CAROLINA
AND THE SOUTHEASTERN UNITED STATES"

MAY 17-18, 1982

THE CITADEL
CHARLESTON, SOUTH CAROLINA

INVITED TECHNICAL CONSULTANTS

Dr. S. G. Anand
Clemson University

Dr. G. A. Bollinger
Virginia Polytechnic Institute and State University

Dr. R. E. Elling
Clemson University

Dr. J. B. Fikon
U.S. Geological Survey

Dr. A. J. Gupta
North Carolina State University

Dr. W. W. Hays
U.S. Geological Survey

Dr. L. F. Kahn
Georgia Institute of Technology

Dr. L. T. Long
Georgia Institute of Technology

Dr. [illegible] McGuire
Ertec Rocky Mountain

Dr. [illegible]
St. Louis University

Dr. G. N. Richardson
Soil and Material Engineers, Inc.

HAZARD AWARENESS AND PUBLIC INFORMATION TASK GROUP
STEERING COMMITTEE

J. W. Wooten (Chairman)
Santee Cooper Public Service Authority

J. B. Bagwell
Baptist College at Charleston

B. L. Curry
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G. W. Horres, Jr.
South Carolina Electric and Gas Company

J. D. Hussin
Law Engineering Testing Company

S. W. Kinard
City of Charleston Commissioners of Public Works

C. S. Matthews
U.S. Army Corps of Engineers

N. T. Olson
South Carolina State Geologist

P. Talwani
University of South Carolina

S. Turner
South Carolina Ports Authority

E. S. Sharpe
Law Engineering Testing Company

I. D. Smith
Soils Consultants, Inc.

B. Wharton
South Carolina Electric and Gas Company

B. Wright
Soil and Material Engineers, Inc.

T. R. Visvanathan
University of South Carolina

Slide 31

This is just a record of the results of our threat conference, which included invited technical consultants from throughout the United States but heavily involving our local people. That is the heart of our program.

The summary of our threat assessment workshop was pretty much as outlined here.

"...THERE IS SUFFICIENT LIKELIHOOD THAT A MAJOR EARTHQUAKE WILL OCCUR IN THE EASTERN U.S., AND VERY POSSIBLY IN THE SOUTHEASTERN U.S., DURING YOUR PRESENT GENERATION."

S.C. SEISMIC SAFETY CONSORTIUM

SLIDE 32

First of all, it acknowledges that there is sufficient likelihood that a major earthquake will occur in the Eastern United States, and very possibly in the Southeastern United States, in our present generation. That is point one.

RECURRENCE INTERVALS FOR SOUTH CAROLINA AND SOUTHEAST REGION

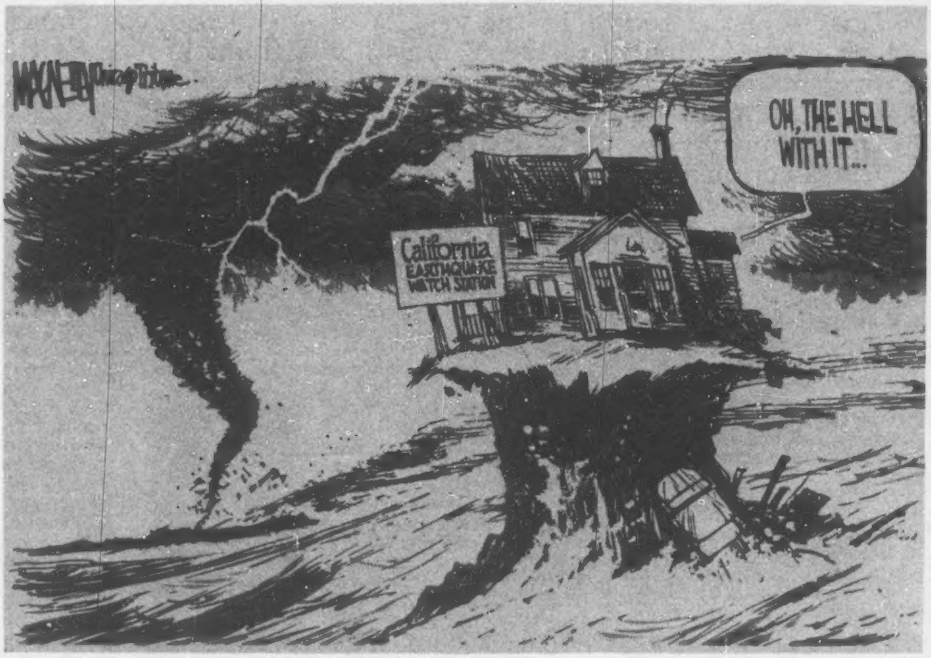
MMI	APPROXIMATE MAGNITUDE	APPROXIMATE RECURRENCE INTERVALS SOUTHEASTERN REGION	SOUTH CAROLINA
VI	5	3 YEARS	10 YEARS
VIII	6	20 YEARS	100 YEARS
X	7	?	?

SLIDE 33

These are recurrence intervals that we have adopted for the Southeastern United States. We are using the modified Mercalli index.

Six would be slight damage to an unreinforced facility. Eight would be slight damage to a reinforced facility with heavy damage to an unreinforced facility. Of course, for the 10, which did occur in Charleston in 1886, there is insufficient statistical data to position again.

[Slide of a cartoon is shown.]



SLIDE 34

We are very much reminded by this cartoon that appeared in our local newspaper last week that our program must address not only the seismic threat, but it must be closely integrated with the other natural hazards, including floods and wind.

[Slide of enumerated program iniatives.]

CERTAIN PROGRAM INITIATIVES

- ESTABLISH TECHNICAL BASELINE THROUGHOUT SOUTHEAST
- PROMOTE VULNERABILITY STUDIES THROUGHOUT SOUTHEAST
- ESTABLISH TECHNOLOGY TRANSFER AND DEVELOPMENT GROUP (TTDG)
- SEISMIC UPGRADE OF EXISTING BUILDINGS
- ASSURE TECHNICAL DESIGN PROFICIENCY
- PROMOTE PARTICIPATION BY PROFESSIONAL ENGINEERING ORGANIZATIONS

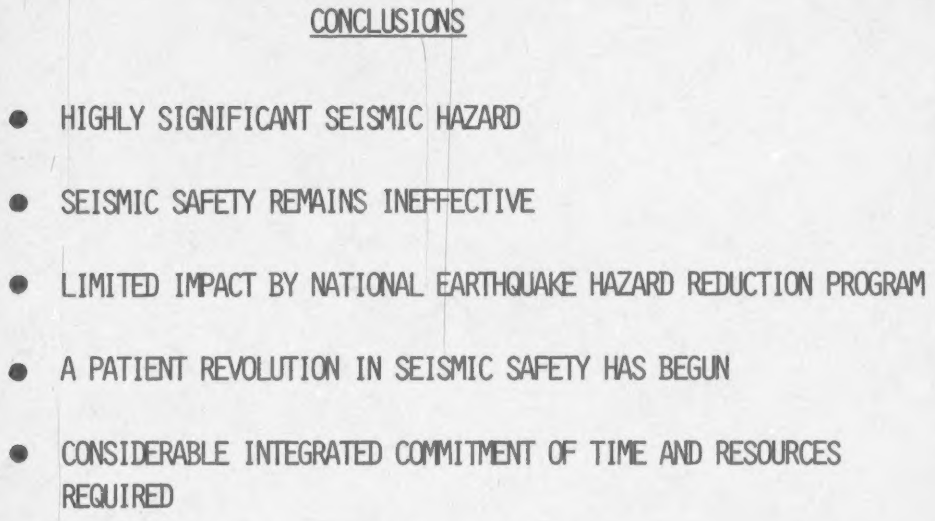
SLIDE 35

There are certain program initiatives as we pursue our major program.

First of all, we need to establish a technical baseline for the Southeastern United States. At the present time we do not even have a technical seismic library in the Southeastern United States. Through the cooperation of our Federal agencies and our west coast and western United States colleagues, we hope to achieve that.

Second, we need to promote vulnerability studies throughout the Southeast, which are very key, we believe, to the public welfare anywhere in an earthquake-prone area. It is through these studies that we quantify what the damage potential is in terms of lost facilities and lives. It is only here, in our opinion, that the communities see for the first time, as Mr. Hansen noted earlier, what it means to the community and what we can do to mitigate the effects.

The Technology Transfer and Development Group—here we would like a sister organization with the ATC that has been established with national members to effect a new tentative code. We note that of the ninety-three participants on that code-deliberating or forming body, only two are from the Southeastern United States, and both are from Memphis, Tenn. We believe it is very important that our community members be involved when these things (codes) are developed.



CONCLUSIONS

- HIGHLY SIGNIFICANT SEISMIC HAZARD
- SEISMIC SAFETY REMAINS INEFFECTIVE
- LIMITED IMPACT BY NATIONAL EARTHQUAKE HAZARD REDUCTION PROGRAM
- A PATIENT REVOLUTION IN SEISMIC SAFETY HAS BEGUN
- CONSIDERABLE INTEGRATED COMMITMENT OF TIME AND RESOURCES REQUIRED

SLIDE 36

In our conclusions we note that we do have a highly significant hazard. Through complacency at the State and the Federal level, it has been overlooked, and we face the dire situation of not having a seismic safety policy, but not, either, the technology base to grow it.

Our seismic safety remains ineffective. There is limited impact by the national earthquake hazard reduction program. I am speaking about those things that have actually been applied in our community. The greatest thing that has happened to us is the Knoxville conference on eastern earthquakes, the first national conference that looked at our side.

Then a patient revolution in seismic safety was begun. Sir, we need every bit of Federal assistance and our sister communities' assistance that we can get to bring ourselves up technologically, so that we can then grow our seismic safety policy.

I think that was the last point.

[Whereupon, the showing of slides by Dr. Lindbergh was concluded.]

I thank you very much, sir, for your attention.

[The prepared statement of Dr. Lindbergh follows:]

SOME VIEWS ON THE NATIONAL EARTHQUAKE PROGRAM AND THE SOUTHEASTERN UNITED STATES

presented to:

Subcommittee on Science, Research and Technology
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

March 15, 1983

Dr. Charles Lindbergh, P.E.

Head, Department of Civil Engineering
The Citadel, Charleston, South Carolina

Cochairman
Southeastern United States Seismic Safety Consortium
South Carolina Seismic Safety Consortium

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SEISMIC SAFETY IN THE SOUTHEASTERN UNITED STATES
. . . A Patient Revolution

I. Introduction

Mr. Chairman and other distinguished members of the Subcommittee, I sincerely appreciate this privileged opportunity to present my views on the seismic safety of our public in the southeastern United States.

There is great potential of earthquakes to kill and damage in the southeastern United States as there is in southern California and parts of other western states. This belief may seem to conflict with our personal experiences that the eastern United States does not experience the frequency of damaging earthquakes that occur in the western United States. Indeed, this difference in frequency of occurrence is one of the two major differences between eastern and western United States earthquakes. However, the other major difference is that which brings into balance the significance of the earthquake threats to these two regions. This difference is in the size of geographical area affected by ground shaking. Such size depends on the magnitude of the earthquake and the rate at which the amplitudes of body and surface seismic waves attenuate or rather decrease with distance from the epicenter. Comparison of the areas affected by the same Modified Mercalli Intensity (MMI) of ground shaking are shown in Figure 1 (Hays, 1981). In order to compare equivalent magnitudes, one should compare the area affected by the great earthquakes of 1906 in San Francisco with the 1811-12 in Madrid, Missouri and the area affected by the larger earthquakes of 1971 in San Fernando with that of 1886 in Charleston. For a given intensity of ground shaking, a significantly larger area of the eastern United States is affected. These results underscore that the attenuation of ground motions extend to much greater distances in the east than in the west.

This phenomenon shows that a much greater seismic hazard will be present for any earthquake occurrence within or adjacent to the southeastern United States. When viewed in context with the increased population, industrial and military densities of the southeastern United States, it strongly suggests that the destructive results of a few or even one great eastern earthquake could rank with that collectively of several western events of characteristically less damaging influence. Dr. Otto Nuttli, a noted seismic researcher of St. Louis University, has referred to this difference in concluding that "when the next major earthquake occurs in the east, it will produce a disaster of unprecedent scale." He has further advised that "a major earthquake will occur in the eastern United States, and very possibly in the southeastern United States, during our present generation. Everyone should be aware that large earthquakes have occurred in the past and will most certainly in the future."

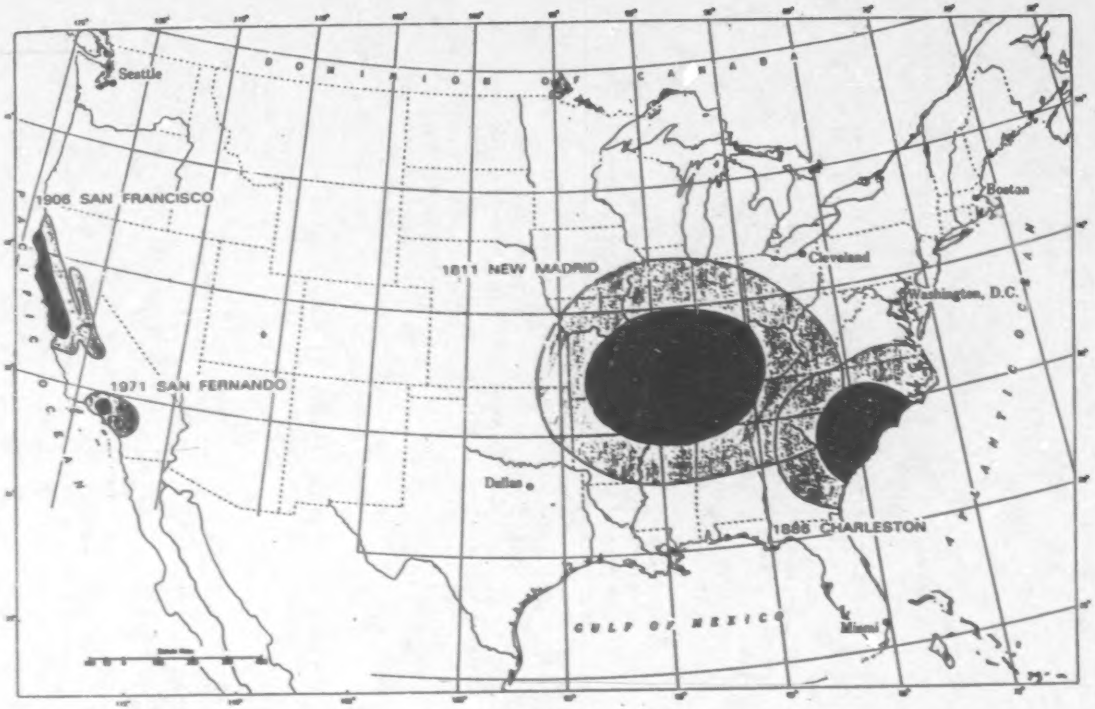

Seattle
D O M I N I O N   O F   C A N A D A
1906 SAN FRANCISCO
1971 SAN FERNANDO
1811 NEW MADRID
Cleveland
Boston
Washington, D.C.
1886 CHARLESTON
Dallas
Miami
G U L F   O F   M E X I C O
P A C I F I C   O C E A N
A T L A N T I C   O C E A N

Figure 1

Comparison of isoseismal contours for earthquakes: the 1906 San Francisco and the 1811-12 New Madrid; the 1971 San Fernando and the 1886 Charleston. The contour lines connect sites having the same value of Modified Mercalli intensity. Each area shown in darker shade corresponds to an intensity of VII or greater and denotes the zone of most severe ground shaking and damage. The area shown in lighter shade corresponds to an intensity of VI; in this area the ground shaking is felt by all, many are frightened and run outdoors, but damage is slight. The effects of ground shaking extend over a much larger area in the Eastern United States.

These two differences in eastern and western United States play a dual role. In addition to distinguishing earthquakes of the two regions, they also are the two most critical factors distinguishing the seismic hazard reduction and mitigative programs of the southeastern United States with the more progressive efforts of the western United States. On the west coast of the United states, most people have been exposed to moderate-size earthquakes. This factor of increased frequency has resulted in strong local and state activities in the western states to increase seismic technical knowledge and promote achievement of public seismic policy. Congressional support provided through such federal agencies as the National Science Foundation, U.S. Geological Survey, National Bureau of Standards and the Federal Emergency Management Agency also have focused on the western regional needs. The results have been commendable. Although significant technology development requirements remain, at least minimum seismic technical knowledge now exists to support public awareness and safety policy establishment. As a consequence, it seems the cardinal objective in the western United States now is the development of more broad public acceptance and adoption of sound seismic safety policy. Dr. Arthur A. Atkisson, a political scientist of the University of Wisconsin, noted this significant transition in commenting that "...it seems likely that political variables may currently be of a greater importance to the initiation and success of earthquake mitigation activities than the current state of scientific knowledge concerning this hazard, the technologic remedies available for its solution, and the economic costs and benefits associated with the applicatons of such remedies..."

This progress has not been similarly achieved in the southeastern United States. The infrequency of large-magnitude earthquakes has resulted in complacency at the national as well as local levels. Despite the many technical and political advances made in the western region, little progress has been made in seismic hazard reduction and mitigation throughout the entire southeastern United States. The seismic safety posture is that of California several decades ago. Public policy developments regarding seismic safety have been insignificant. Even more disturbing is the unchanged persistent need to establish at least minimum adequate knowledge at all professional and public levels. We are not prepared to cope with the social and economic impacts from either a recurrence of a major earthquake like that of 1886 in Charleston or from smaller damaging earthquakes. But there is one major difference in opportunity. Now, our region has available significant technology and experience developed largely in the western United States. In sober realization of these factors and with developing federal support and encouragement, significant effort is beginning in our region to meet the grave seismic hazards facing our communities. Our general objectives are twofold. First we are striving to increase regional technical knowledge and capability through regional technical developments as well as technology and experience transfer from our sister western states. Building upon this base and increased public awareness, our second objective is to achieve public adoption of effective seismic policy. Our approach is fundamentally different in that broad community level involvement is being developed prior to seeking the legislative mandating of seismic policy. This "grassroots" approach is to accelerate technology transfer to the lowest levels and to insure public acceptance of seismic safety legislation once enacted.

We understand the effort will require considerable commitment of time and resources, including that of the federal government. However, the dire risk to the safety of our public leaves no responsible alternative. In this regard, the Subcommittee is strongly requested to encourage and otherwise support the full commitment to this task of the National Bureau of Standards, U.S. Geological Survey, National Science Foundation, Federal Emergency Management Agency and the U.S. Nuclear Regulatory Agency. The program demands are broad and involve the specific specialized responsibilities of each of these agencies. It is imperative that federal, regional, state and local efforts be well coordinated. The following sections of this paper describe seismic safety program organizations and developments in the southeastern United States. They emphasize the integrated support needed and suggest means of insuring adequate coordination of such support.

II. Regional Seismic Safety Program Background, Organization and Status

2.1 Program Background

National seismic safety technology and program policy advancements generally have been limited to the western region of the United States. Noteworthy seismic program developments in Massachusetts are the only apparent exception. Certainly, much of the technology and experience basically developed in these other states are of strong potential benefit to the eastern states. However, this progress has not yet been made. Consequently, a considerable imbalance exists between the earthquake damage reduction and mitigation postures of the eastern and western United. In September 1981, a national conference was held in Knoxville, Tennessee, to address this imbalance. It marked the first time that engineers, geologists and planners assembled to discuss the many important issues related to earthquake hazards in the eastern United States. More importantly, it was the first major breakthrough in seismic technology and experience transfer to the eastern United States. Over six hundred people participated, reflecting wide felt concern of the public as well as government and technical communities. Most of the participants were from the eastern states. They collectively represented the full range of persons criticial to seismic safety program development. They included the technical skilled and unskilled, the experienced and the inexperienced, the city and rural dwellers, the politician and the engineer, as well as the government official and public member. The presentations emphasized the need for marked seismic safety improvements in the east, taking full advantage of the many significant advancements of the western United States. Considerable attention was focused on the Charleston earthquake of 1886 and the probability of the recurrence of such devastation. The last two days of the week conference were devoted to regional self-examination of seismic safety needs and development of draft 5-year action plan to evolve seismic safety policy for the southeastern, central and northeastern United States regions. In my view, this national conference, including associated regional workshops was excellent and perhaps is currrently the singularly most important effective contribution of the National Earthquake Hazards Reduction Program to the southeastern United States and possibly the entire eastern region. Considerable acknowledgement is due the numerous professional, federal and state organizations supporting the major meeting. Primary sponsors were the Federal Emergency Management Agency (FEMA), the United States Geological Survey (USGS), and the National Science Foundation (NFS). The preceding statement regarding the importance of the national conference is not intended to degrade that of other advancements such as the excellent tentative seismic building code (ATC 3-06) achieved by the Applied Technology Council with the support of the National Science Foundation and the National Bureau of Standards. These developments are highly important but remain as potential improvements not yet effectively applied in our region.

The Southeastern Regional Workshop I attended was most interesting and productive. Table 1 lists the participants and their communities. We soberly concluded that the Southeastern United States is not prepared to cope with the social and economic impacts from either a recurrence of a major earthquake like the 1886 in Charleston, SC and 1811 in New Madrid, Missouri or from smaller damaging earthquakes. Our workshop participants felt that constructive and prudent steps must be taken with high priority to introduce change leading to a seismic safety policy that will improve the state of the earthquake preparedness in the southeastern United States. Such policy is needed especially to reduce losses from moderate and large earthquakes which happen more frequently than a major one.

2.2 Program Organization - Southeastern United States Seismic Safety Consortium

The most significant accomplishment of the Southeastern Regional Workshop was to establish the Southeastern United States Seismic Safety Consortium (SEUSSSC) and appointing an Ad Hoc steering committee to guide its continued development. The cochairpersons are myself, Dr. Charles Lindbergh, Head of the Civil Engineering Department, The Citadel, Charleston, South Carolina and Professor Joyce B. Bagwell of the Baptist College at Charleston, South Carolina. The three other committee members include Dr. Ajaya K. Gupta, Department of Civil Engineering, North Carolina State University; Dr. Leland T. Long, Department of Geology, Georgia Institute of Technology and Dr. Gilbert A. Bollinger, Department of Geologic Sciences, Virginia Polytechnic Institute and State University. Like other eastern regions, the Southeastern United States Workshop developed a draft 5-year action plan for improving earthquake preparedness and mitigation in its geographical region. The SEUSSSC intends to serve as the entity to implement the recommendations of the draft five year action plan and to evolve a seismic safety policy for the southeastern United States achieved through coordinated but independent state seismic programs.

TABLE 1

SOUTHEASTERN UNITED STATES WORKSHOP PANEL MEMBERS

Professor G. A. Bollinger (Chairperson)	Virginia Polytechnic Institute and State University, Blacksburg, VA
Professor Joyece B. Bagwell (Rapporteur)	Baptist College at Charleston Charleston, South Carolina
Dr. James Beavers	Union Carbide Corporation
Ms Paula Gori	U.S. Geological Survey
Ms Marjorie Green	Seattle Research Center
Professor Ajaya K. Gupta	North Carolina State University
Dr. Walter Hays	U.S. Geological Survey
Mr. Dennis Johnson	American Red Cross
Mr. Keith Keister	Peacetime Disaster Preparedness Commonwealth of Virginia
Lt. Col. Charles Lindbergh	The Citadel, Charleston, SC
Professor Leland T. Long	Georgia Institute of Technology
Mr. Donald P. Moore	Southern Company Services, Inc.
Dr. Donald R. Nichols	U.S. Geological Survey
Mr. Travis Ratcliff	Federal Emergency Management Agency
Professor Blaine Roberts	University of South Carolina
Dr. John B. Scalzi	National Science Foundation
Ms Hilary Whittaker	National Governors Association

Figure 2 illustrates the intended foundations of strong individual state seismic safety consortiums, eventually transitioning to official commission status. SEUSSSC functions as an integrative and coordinating organizational element for the individual consortiums of southeastern states. Technology transfer and definition of seismic research efforts for federal sponsorship are but two examples of anticipated benefits.

2.3 Program Orgainzation - South Carolina Seismic Safety Consortium

The South Carolina Seismic Safety Consortium (SCSSC) was organized to develop and influence the implementation of a five year comprehensive action plan for earthquake preparedness and mitigation in South Carolina with emphasis on its lowcountry region. This effort builds upon the draft five year action plan developed at the Knoxville Conference and Workshop. The SCSSC includes approximately seventy (70) representatives of government, professional associations, universities and the public sector. This consortium is to serve as the prototype state program for other state consortiums in the southeastern United States, all of which are to be ultimately integrated for coordination under the newly developed Southeastern United States Seismic Safety Consortium.

The South Carolina Section of the American Society of Civil Engineers, Eastern Branch, and the Charleston Higher Education Consortium joined to lead the establishment of the South Carolina Seismic Safety Consortium. Small but important support is being provided by the United States Geological Survey, the Federal Emergency Management Agency, and the Citadel Development Foundation. Dr. Walter Hays, U.S. Geological Survey, has been the federal participant most responsible for the formation and success of the SCSSC as well as the SEUSSSC.

The South Carolina Seismic Safety Consortium has three major objectives. They are:

a. Act to develop and influence the implementation of a comprehensive state seismic safety policy insuring adequate earthquake preparedness and mitigation in South Carolina with emphasis on its lowcountry region.

b. To provide synergism and technical qualification among engineers, geologists, seismologists, planners, governmental leaders and the public as necessary to insure adequate sustained implementation of seismic safety policy.

c. To insure federal and state seismic research and development programs adequately address the technical needs of South Carolina and the southeastern United States.

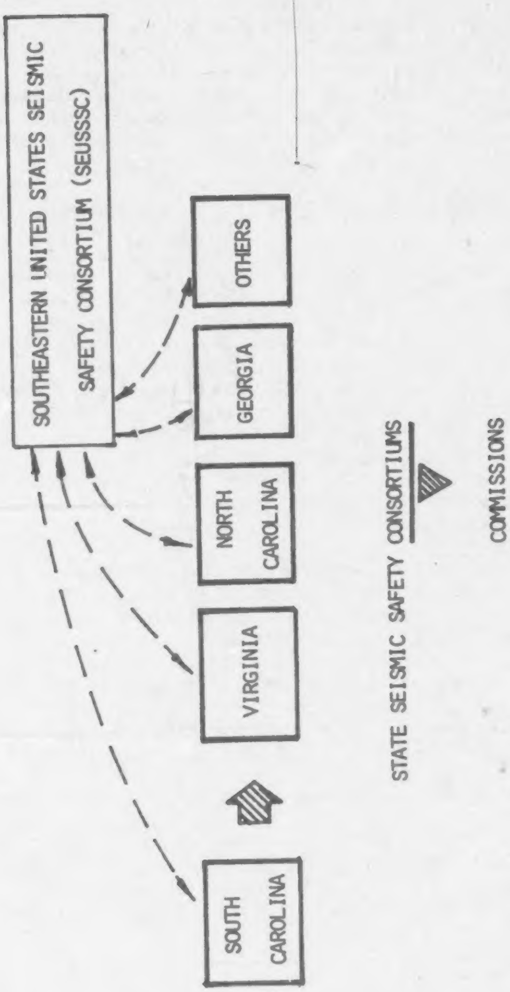

SOUTHEASTERN UNITED STATES SEISMIC SAFETY CONSORTIUM (SEUSSSC)
OTHERS
GEORGIA
NORTH CAROLINA
VIRGINIA
SOUTH CAROLINA
STATE SEISMIC SAFETY CONSORTIUMS
COMMISSIONS

Figure 2

The SCSSC is organized into five task groups as illustrated in Figure 3. The specific responsibilities of each task group are defined in Appendix A. As reflected in their leadership, the task groups include representatives of government, professional associations, universities, industry and the public sector. The consortium's organization including the five task groups and their chairmen are:

Consortium Co-chairmen

Dr. Charles Lindbergh, P.E.
The Citadel - Civil Engineering Department

Professor Joyce B. Bagwell
Baptist College @ Charleston - Chemistry/Geology Department

Consortium Task Groups

Hazard Awareness and Public Information Task Group

Mr. J. M. Wooten (Chairman)
Santee Cooper Public Service Authority

Local Earthquake Resistant Design Task Group

Colonel M. R. Harlan (Chairman)
The Citadel - Department of Civil Engineering

Response to a Damaging Earthquake Task Group

Mr. S. W. Kinard (Chairman)
City of Charleston Commissioners of Public Works

Sector Participation Task Group

Mr. Lewis Hudgins (Chairman)
Administrative Assistant to Mayor of Charleston

Intergovernmental and Organizational Relations Task Group

Dr. Thomas Hansen (Chairman)
Director BCD Council of Governments

2.4 SCSSC Program Plan

The SCSSC program plan is structured to develop and implement a five year action plan for seismic safety improvements within South Carolina. Initial direction is being provided by the preliminary five year plan drafted at the Knoxville conference workshop. As illustrated in Figure 4, there are three programs phases. The first phase was one of consortium organization. The current or second phase of the three-phase effort is to allow South Carolina to share the seismic safety program experiences and engineering design technology

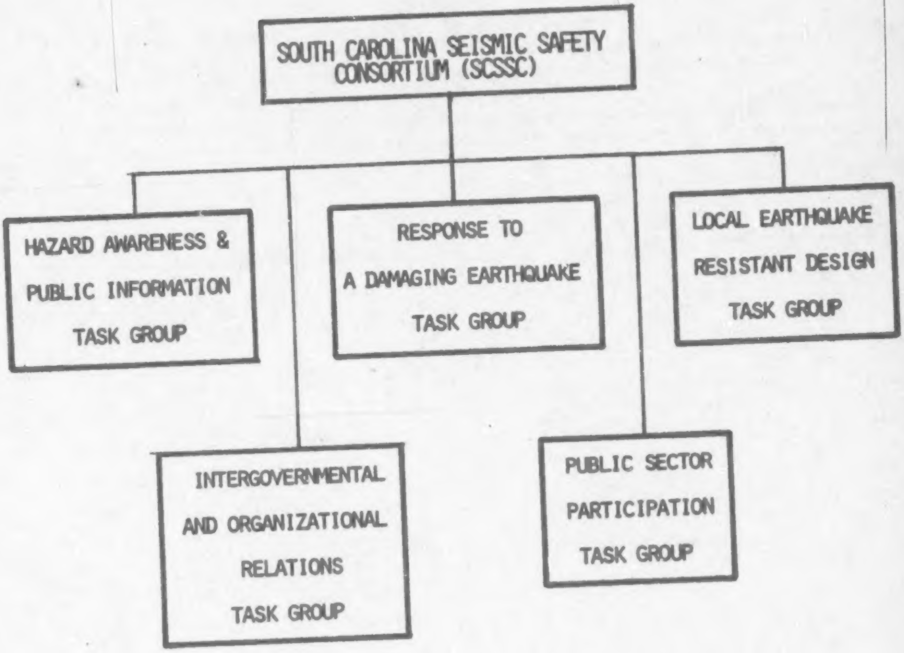

SOUTH CAROLINA SEISMIC SAFETY CONSORTIUM (SCSSC)
HAZARD AWARENESS & PUBLIC INFORMATION TASK GROUP
RESPONSE TO A DAMAGING EARTHQUAKE TASK GROUP
LOCAL EARTHQUAKE RESISTANT DESIGN TASK GROUP
INTERGOVERNMENTAL AND ORGANIZATIONAL RELATIONS TASK GROUP
PUBLIC SECTOR PARTICIPATION TASK GROUP

Figure 3

PROGRAM PLAN

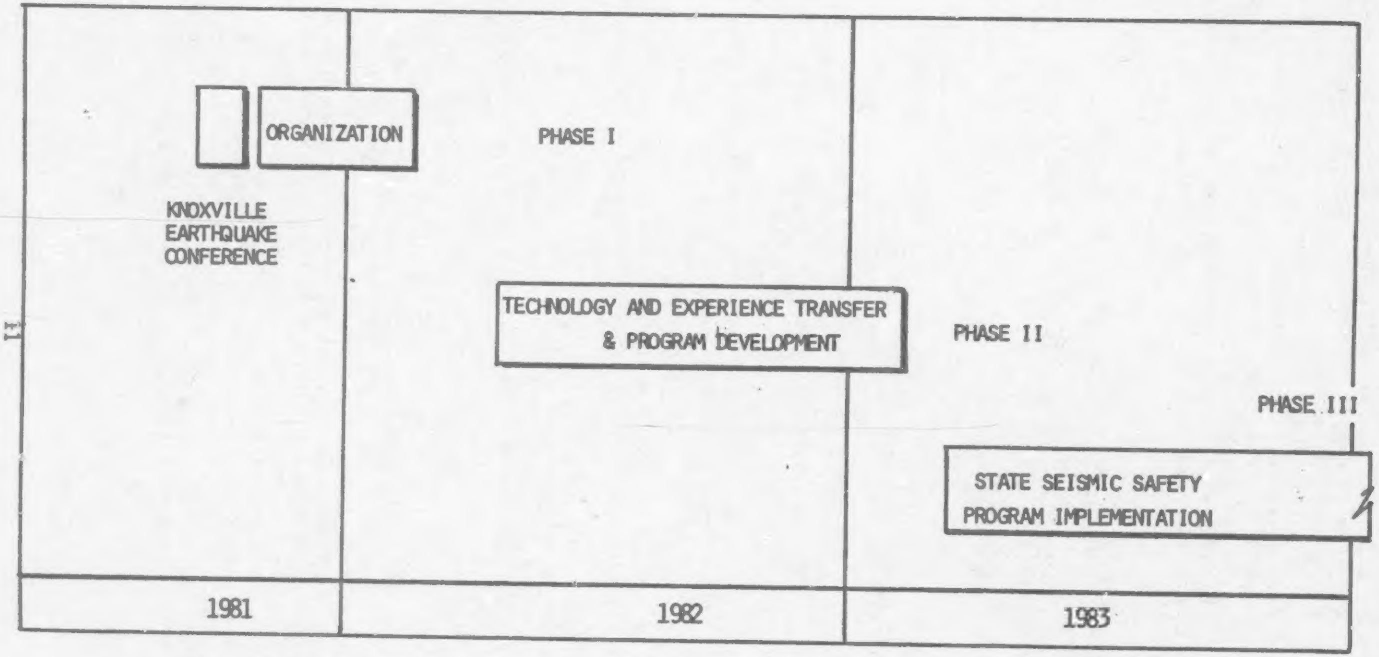

ORGANIZATION
KNOXVILLE
EARTHQUAKE
CONFERENCE
PHASE I
TECHNOLOGY AND EXPERIENCE TRANSFER
& PROGRAM DEVELOPMENT
PHASE II
PHASE III
STATE SEISMIC SAFETY
PROGRAM IMPLEMENTATION
1981
1982
1983

Figure 4

accrued by certain other states, primarily in the western United States. A five session series of meetings is to underpin this phase. The session topics are listed in Table 2. Through this technology and experience transfer interaction, a common level of information and association will be established among SCSSC committee members regarding seismic risk awareness, relevant programs of federal and other state seismic safety groups and preparedness conditions within South Carolina. The SCSSC will be in a good position to chart the course of South Carolina's state seismic safety development.

TABLE2

TECHNOLOGY AND EXPERIENCE TRANSFER PROGRAM

Session 1	Earthquake Hazards and Risk in South Carolina and the Southeastern United States
Session 2	Seismic Safety Planning Strategies; Lessons from Utah and California
Session 3	Earthquake Resistant Design Considerations
Session 4	Seismic Safety Planning Strategies; Lessons from Massachusetts
Session 5	The Governmental Viewpoint on South Carolina Seismic Safety

Each session consists of a two-day workshop of interaction between particular SCSSC task group(s) and a set of participating consultants from other states and the federal government. In each case, the continued interface subsequent to the workshop between the conferees is intended to give final definition to a particular section of the five year plan and its implementation. While promoting highly specialized program developments, it is intended to further the overall seismic safety knowledge of the general membership (i.e., all five task groups). Informed integrated action is the necessary objective.

The first workshop was held at The Citadel in Charleston, South Carolina during May 17 and 18, 1982. It was designated "The Hazard Awareness and Public Information Task Group Workshop." As planned, it produced a white paper providing a consensus on seismic threat to the southeastern United States with emphasis on South Carolina and its low country region, including Charleston. This document is entitled "Earthquake Hazards and Risk in South Carolina and the southeastern United States." It is intended to be the foundation for the five year seismic program in South Carolina and, to considerable extent, throughout the southeastern United States region. This definition of threat and associated prediction capability was resolved by the SCSSC's Hazard Awareness and Public Information Task Group, with the technical assistance of select consultants. It was based on the current state of relevant art and science. As a secondary objective, the workshop defined certain public actions and strategies capable of enhancing seismic prediction capability within the southeast. Figure 5 illustrates some extracts from the workshop's program. It lists the participating membership of the Hazard Awareness and Public Information Task Group and identifies the supporting invited technical consultants. This figure is significant in that it indicates breath of organization as well as noteable participation by invited national consultants, stimulating technology transfer to our region.

The Hazard Awareness and Public Information Task Group concluded that "... there is sufficient likelihood that a major earthquake will occur in the Eastern United States, and very possibly in the southeastern United States, during our present generation." Based upon analysis of historical earthquakes in the southeastern United States and the frequency with which they have occurred, the recurrence interval for South Carolina and the southeast region were established for SCSSC planning as shown in Table 3. Appendix B defines the damage significance of the listed Modified Mercali Intensities (MMI).

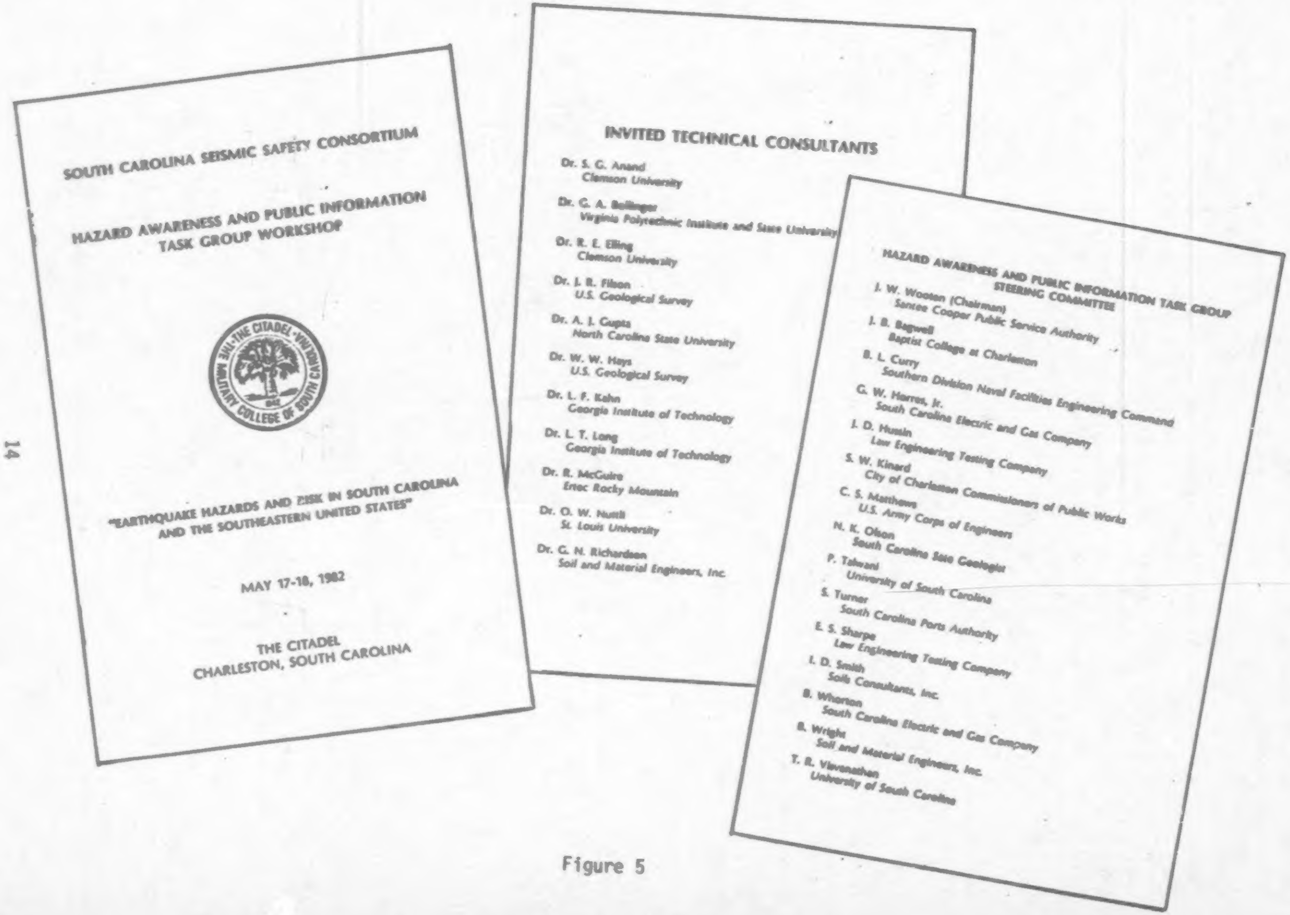
Table 3

Recurrence Intervals for South Carolina and Southeast Region

	Approximate	Approximate Recurrence Interval	
MMI	Magnitude	Southeastern Region	South Carolina
VI	5	3 years	10 years
VIII	6	20 years	100 years
X	7	(?)	(?)

In its deliberations, the task group considered the Charleston earthquake of 1886. Figure 6 is a map of the city at that time. Figure 7 illustrates the isoseismals of that great seismic event. However, actual damage inspections are more revealing than isoseismals. Figures 8 through 12 are some photographs of actual damage. Other photographs are provided as Appendix C. The rare records effectively capture the high degree of resulting devastation.

The second session, Seismic Safety Planning Strategies: Lessons: from California and Utah, was held at the Baptist College near Charleston on November 15-16, 1982. The purpose of the workshop was for regional people to learn the lessons of seismic safety planning of California and Utah and determine how these lessons could be applied to the southeast, emphasizing South Carolina and its lowcountry region. The white paper on the Southeastern Seismic Hazard developed earlier by



SOUTH CAROLINA SEISMIC SAFETY CONSORTIUM

HAZARD AWARENESS AND PUBLIC INFORMATION
TASK GROUP WORKSHOP

"EARTHQUAKE HAZARDS AND RISK IN SOUTH CAROLINA
AND THE SOUTHEASTERN UNITED STATES"

MAY 17-18, 1982

THE CITADEL
CHARLESTON, SOUTH CAROLINA

INVITED TECHNICAL CONSULTANTS

- Dr. S. G. Anand
  - Clemson University
- Dr. G. A. Bollinger
  - Virginia Polytechnic Institute and State University
- Dr. R. E. Elling
  - Clemson University
- Dr. J. R. Filson
  - U.S. Geological Survey
- Dr. A. J. Gupta
  - North Carolina State University
- Dr. W. W. Hays
  - U.S. Geological Survey
- Dr. L. F. Kahn
  - Georgia Institute of Technology
- Dr. L. T. Long
  - Georgia Institute of Technology
- Dr. R. McGuire
  - Ertec Rocky Mountain
- Dr. O. W. Nuttli
  - St. Louis University
- Dr. G. N. Richardson
  - Soil and Material Engineers, Inc.

HAZARD AWARENESS AND PUBLIC INFORMATION TASK GROUP
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- J. W. Wooten (Chairman)
  - Santee Cooper Public Service Authority
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- B. Whorton
  - South Carolina Electric and Gas Company
- B. Wright
  - Soil and Material Engineers, Inc.
- T. R. Visvanathan
  - University of South Carolina

Figure 5

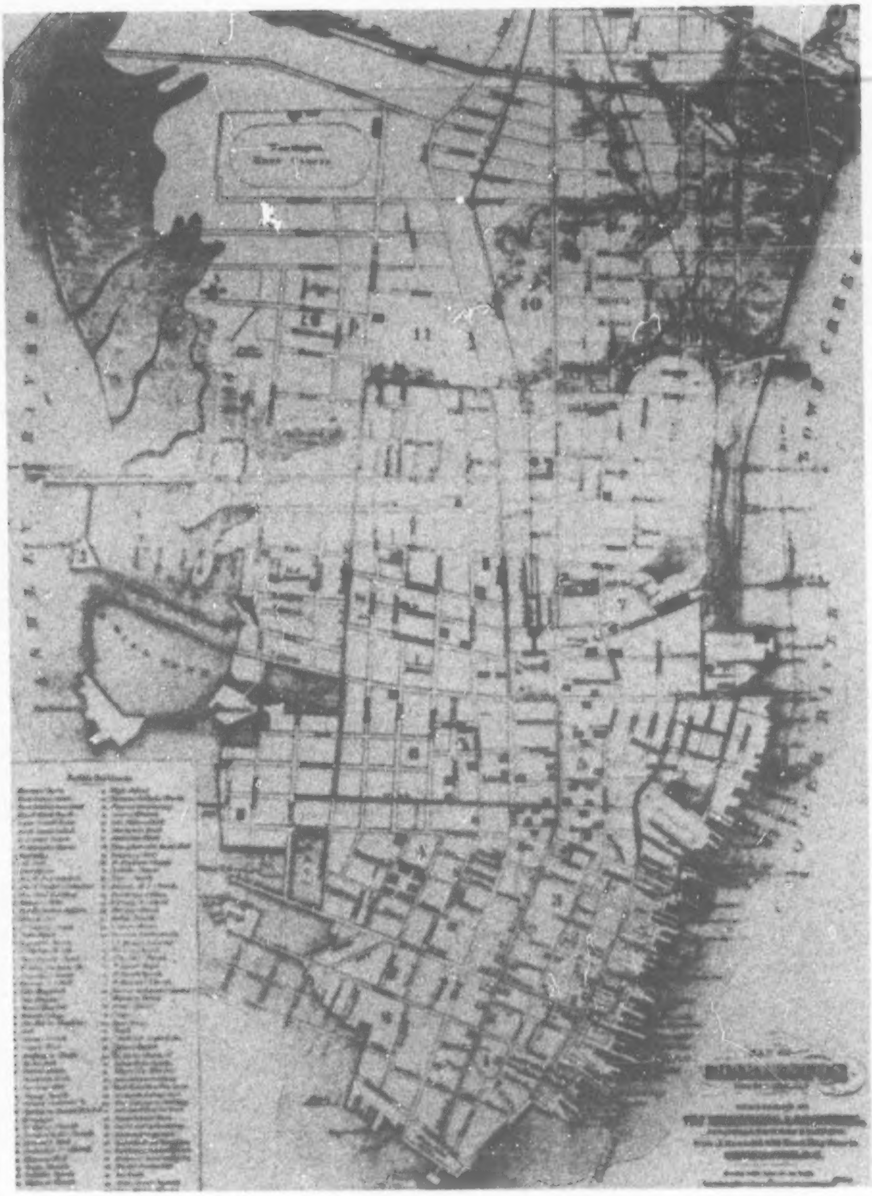


Figure 6

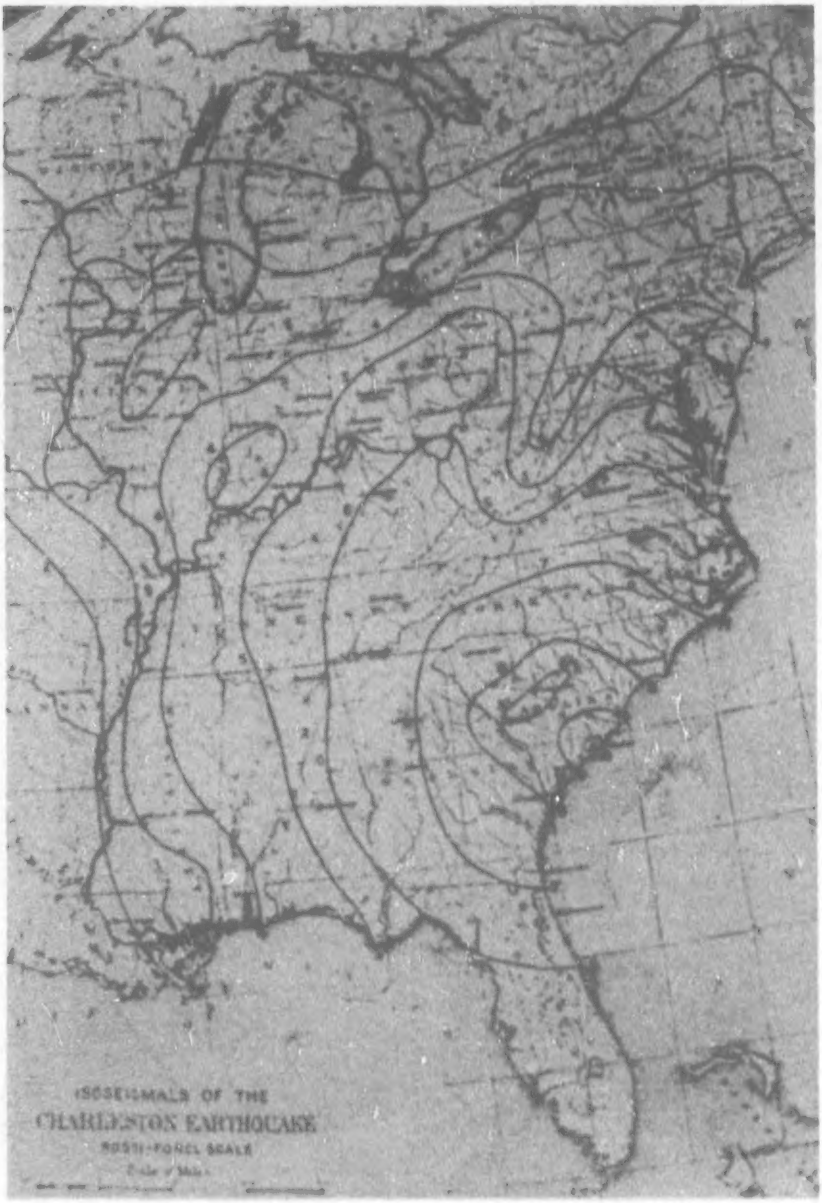

ISOSEISMALS OF THE
CHARLESTON EARTHQUAKE
ROSSI-FOREL SCALE
Scale of Miles

Figure 7

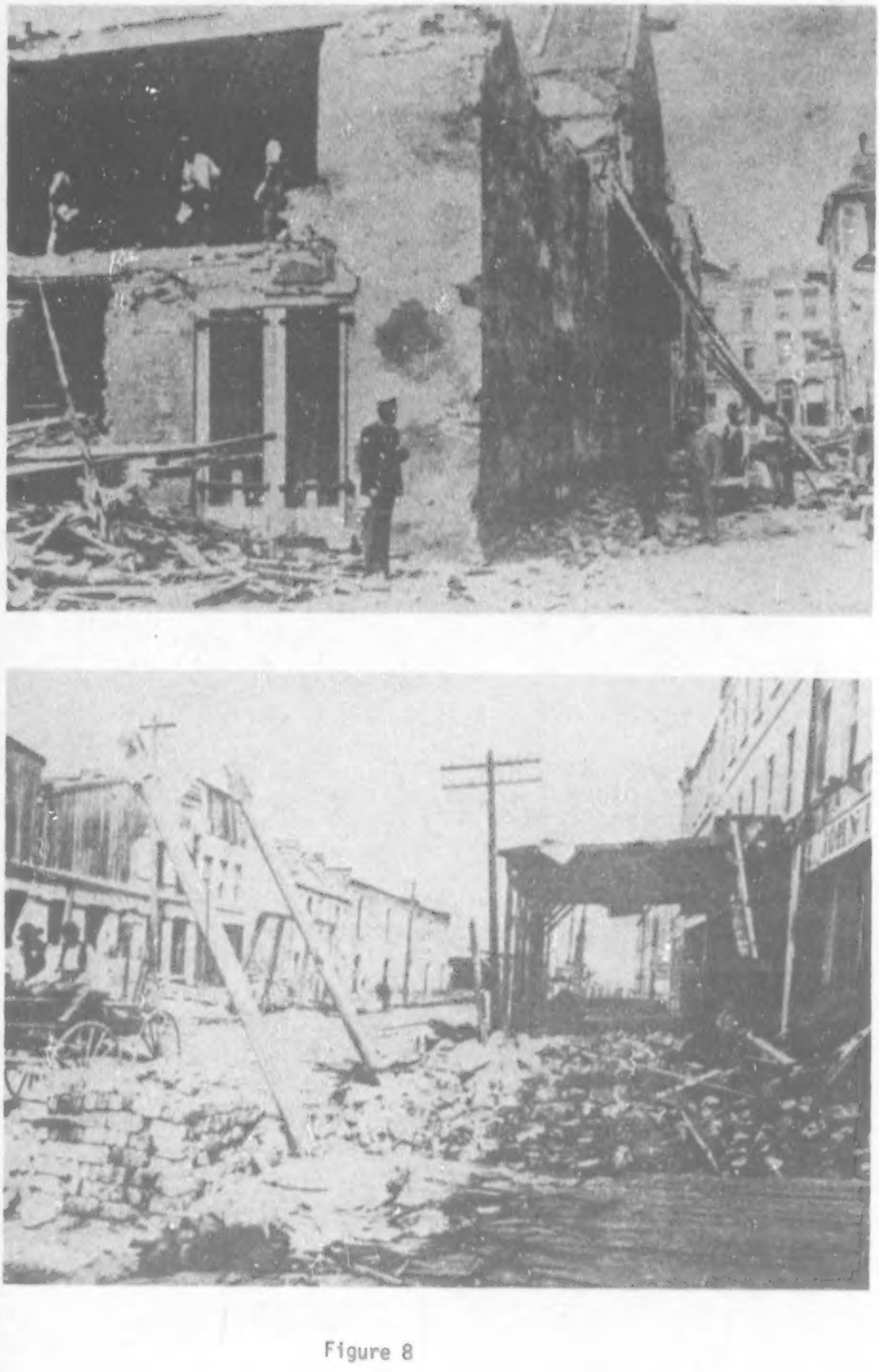


Figure 8

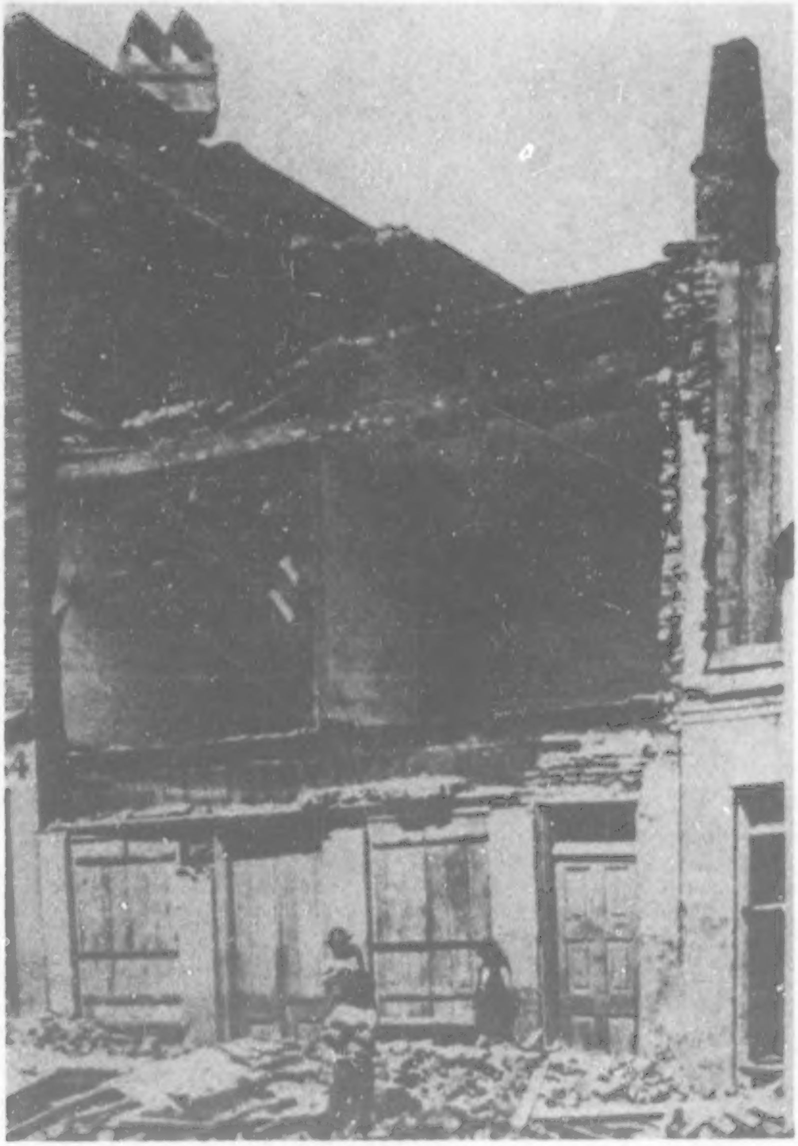
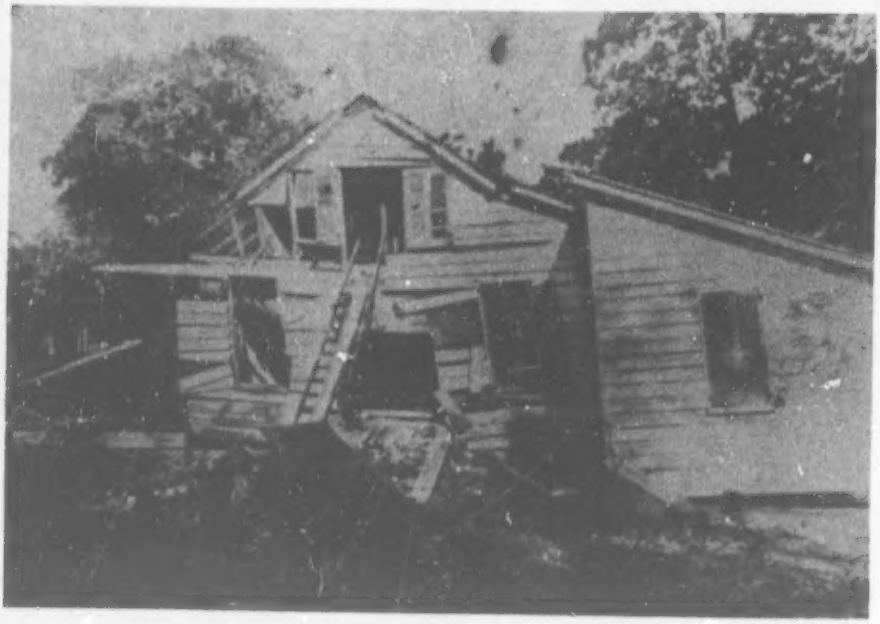


Figure 9



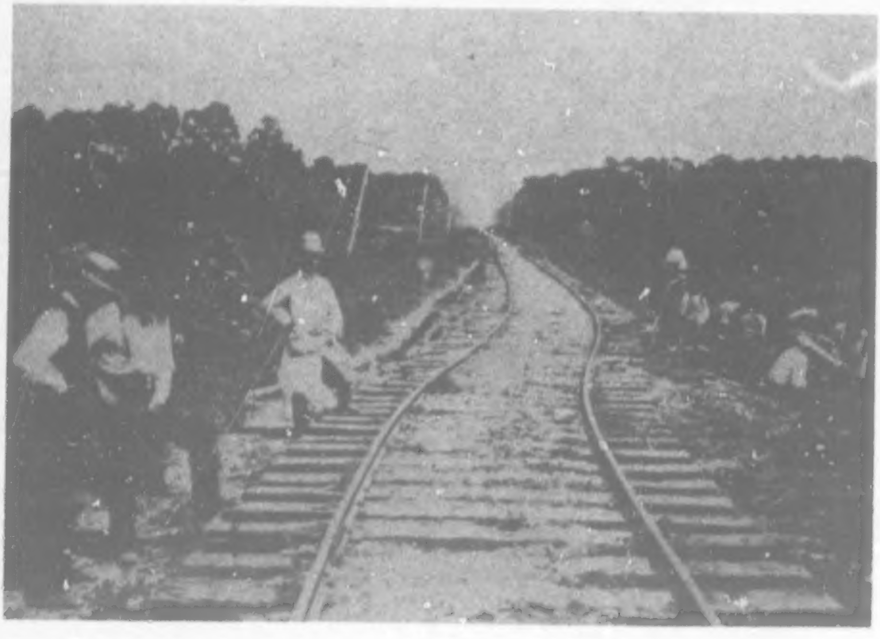
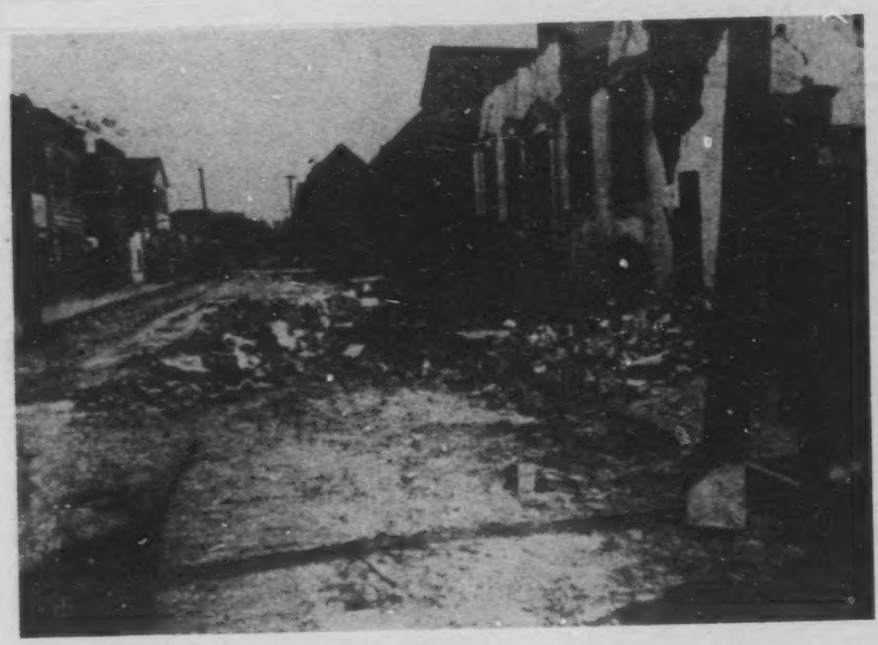


Figure 10



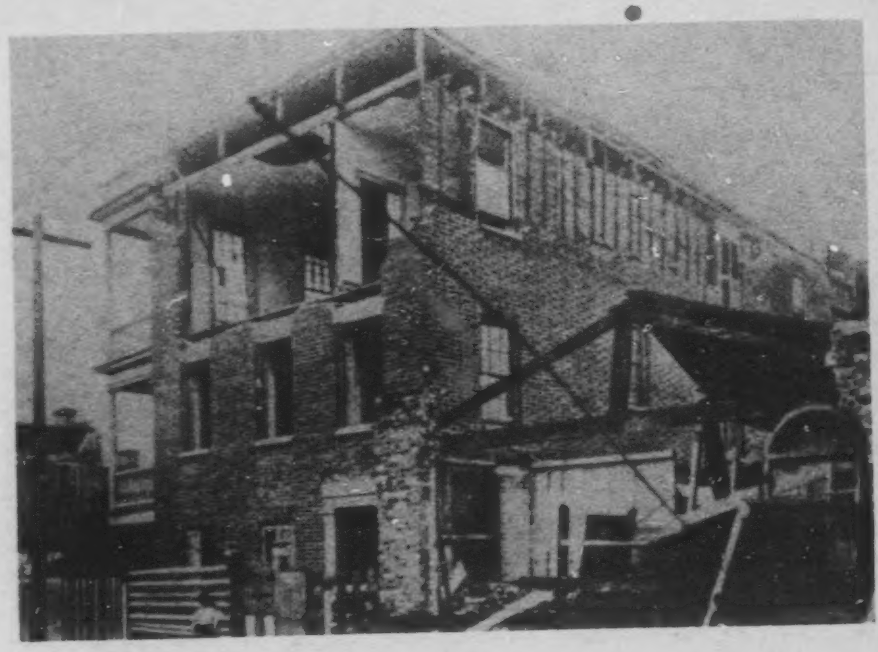
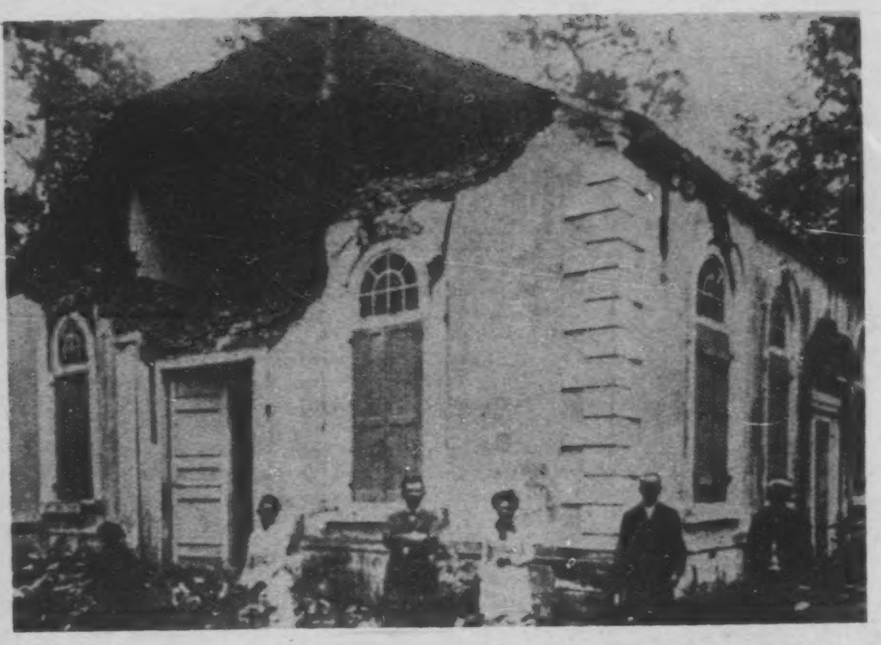


Figure 11



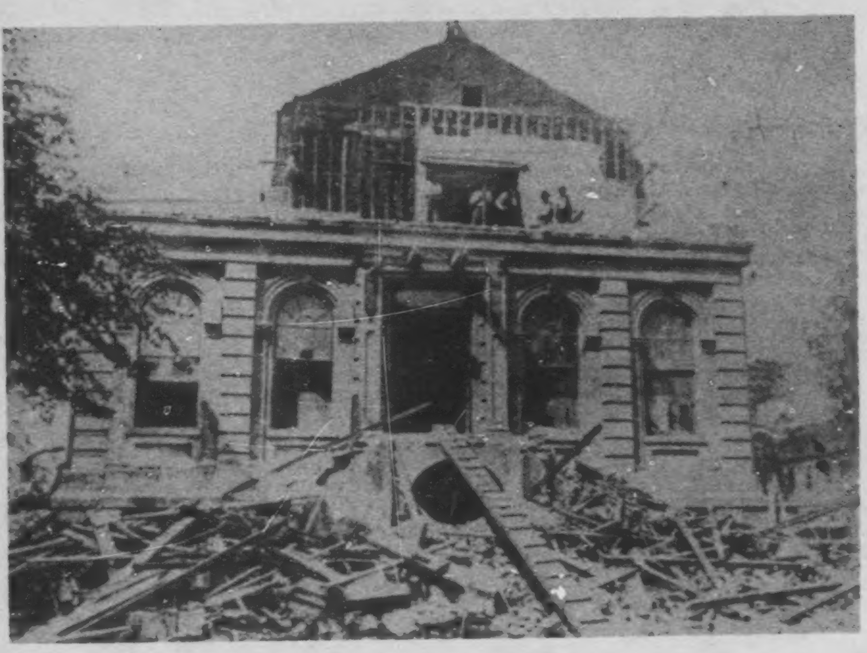


Figure 12

the consortium was used as a background. Keynote speakers included:

Dr. Richard Olson	Project Director Seismic Safety Policy Research Center University of Redlands Redlands, CA
Mr. Delbert B. Ward	Structural Facilities, Inc. Salt Lake City, Utah] Formerly, Executive Director of Utah Seismic Safety Advisory Council
Mr. Earl Schwartz	Chief, Conservation Bureau Department of Buildings and Safety City of Los Angeles, CA

The workshop was attended by over seventy people of varied disciplines. Excellent news coverage resulted in extensive regional televison, radio and newspaper articles. Some examples of newspaper accounts are provided as Appendix D. They are typical in their acceptance of the eastern earthquake hazard and concern that awareness and preparation are apparently grossly inadequate.

The next session will be conducted later this year and will emphasize earthquake design considerations. Certain west coast design firms, the National Science Foundation, the National Bureau of Standards and the Earthquake Engineering Research Insitute will be asked to participate. As is the usual situation, all particpants will be expected to volunteer their services.

III. Certain Program Initiatives

As the Technology and Experience Transfer and Program Development Phase of the SCSSC's seismic safety program progresses, several specific program initiatives have been established and are being advanced as opportunities permit. They are listed in Table 4 and discussed below.

3.1 Establish Adequate Technical Baseline Throughout the Southeast

Technical information and trained capability regarding seismic related technology is very limited throughout the southeastern United States. Broad improvement is necessary for the development and maintenance of adequate seismic safety policy. Several initiatives are currently being worked. First, a centralized regional seismic reference center is essential. None exist throughout the entire southeastern United States. Second, regional unique technical requirements exist. Regional seismic research and design development activity needs to be dramatically increased among the commercial as well as

TABLE 4
CERTAIN PROGRAM INITIATIVES

- ESTABLISH ADEQUATE TECHNICAL BASELINE THROUGHOUT THE SOUTHEAST
- PROMOTE VULNERABILITY STUDIES THROUGHOUT THE SOUTHEAST
- ESTABLISH TECHNOLOGY TRANSFER AND DEVELOPMENT GROUP (TTDG)
- SEISMIC UPGRADE OF EXISTING BUILDINGS
- DEMONSTRATION OF TECHNICAL DESIGN PROFICIENCY
- AMERICAN SOCIETY OF CIVIL ENGINEERS' ACCEPTANCE OF SEISMIC RESPONSIBILITIES

educational sectors. Training and experience derived from such technology acquisition would directly benefit the regular practitioner and public. In this regard, significantly increased EERI, FEMA, USGS and NSF support are mandatory. Third, seismic design instruction needs to be routinely offered in regional engineering centers. Fourth, much of the limited seismic design accomplished is the product of non-regional or western professionals. These growth opportunities in design and experience growth are being lost for local engineers. At least minimum participation by local engineers in all regional seismic design projects should be mandated.

3.2 Promote Vulnerability Studies Throughout the Southeast

Probably, one of the most important keys to successful public seismic safety policy is the community vulnerability study. The vulnerability study assesses the local earthquake hazard, and, considering the damage susceptibility of existing facilities and systems, determines the extent of community damage probable in the event of a likely seismic event. From this determination, the impact on the community is qualified in terms of killed or injured people, reduced critical services, etc. The current critical need for such studies in communities throughout our region is reflected in recent letter to me by Mr. Thomas L. Hansen, Executive Director, Council of Governments for of Governments for Berkeley, Charleston and Dorchester Counties in South Carolina. His statement is simple but profound in that it captures public sentiment common in the southeastern United States and underscores the urgency of the vulnerability study in achieving code adoption, improved disaster preparedness and other seismic safety advancements. Mr. Hansen wrote, "Personally, I believe that most people in this region are aware of the fact that a major earthquake could occur at any time. I do not believe that they are aware of either the possible damages that could occur as a result of a major episode, or, of what may be done to mitigate damages."

Vulnerability studies have been concluded for only four cities in the entire United States; San Francisco, Los Angeles, Puget Sound and Salt Lake City. Several other cities in the central United States have initiated studies. In all cases, these studies have been led and largely conducted by visiting consultants and other technical study personnel. The SCSSC and The Citadel in Charleston, South Carolina, have commenced the first such vulnerability study in the southeastern United States. Its project director is Colonel Maurice R. Harlan, a faculty member in the Department of Civil Engineering at The Citadel. With valued FEMA support, this vulnerability study is being accomplished for Charleston, South Carolina. It is to serve as a prototype for the southeastern United States. Unlike all others, this study is being done by local people. The intent is to retain locally the technical experience that only comes from direct participation, to minimize study costs allowing more communities to likewise benefit and, finally, to produce a preliminary "vulnerability study handbook" for use by other regional communities. Significant technical assistance has been donated to our local vulnerability study team by several national consultants. They included Dr. Samy A. Adham, Agbabian Associates, Los Angeles, California, Mr. Henry J. Degenkolb, H.J. Degenkolb Associates Engineers of San Francisco, California; Dr. Winfred O. Carter, Utah State University, Logan, Utah; and Dr. Anschel Schiff, Purdue University, Lafayette, Indiana.

Certainly, the vulnerability study is emerging as a necessary element for a community's earthquake preparedness and hazards mitigation. This past summer, I attended the excellent Multi-Protection Design Summer Institute, Emergency Management Institute of FEMA located at Emmitsburg, Maryland. The instruction in earthquake and relevant wind engineering was most effective and would greatly assist an engineer to instruct as well as practice seismic design. Its director, Mr. Charles House, and his staff are to be commended. I believe this institute should be given an expanded role. It should provide more wide spread service to engineers in the eastern United States. Even more importantly, its curriculum should be expanded to include instruction to community engineers in the proper conduct of vulnerability studies. Instructional material should include technical handbooks on how community engineers can direct vulnerability studies. Only through such important measures will most communities be able to benefit from these evaluations.

3.3 Establish Technology Transfer and Development Group (TTDG)

As the federal government and our western counterparts proceed to upgrade seismic building code provisions in line with the "Tentative Provisions for the Development of Seismic Regulations for Buildings" (ATC 3-06) prepared by the Applied Technology Council, the southeastern United States wrestles in near obsolecence with the acceptance and implementation of the now aging seismic provisions of the Uniform Building Codes or the Southern Building Code, Figure 13. A major impediment has been the essential absence of southeastern representation on the Applied Technology Council. Of the ninety (90) project participants identified in the ATC 3-06 report, only two are from the southeastern United States, both from Memphis, Tennessee. Usually, codes development and acceptance require considerable time. However much utility is realized throughout the development process by the participants as they engage in continuing deliberations. Through them, technology can normally be upgraded years ahead of final code adoption. This benefit has been realized by the southeastern region as it essentially has not effectively been a participant. Wide concerted efforts are now being charted elsewhere to guide community acceptance of the more updated tentative code provisions. On the other hand, we continue to encourage effective implemenatation of standard UBC and SBC code provisions.

In this major issue, seismic safety advancements within the southeast depend heavily upon strong support by the Center for Building Technology of the National Bureau of Standards and the National Science Foundation. Specifically, a Technology Transfer and Development Group (TTDG) must be established and maintained under the direction of the Southeastern United States Seismic Safety Consortium to effectively transfer ATC 306 baseline technology to the southeastern

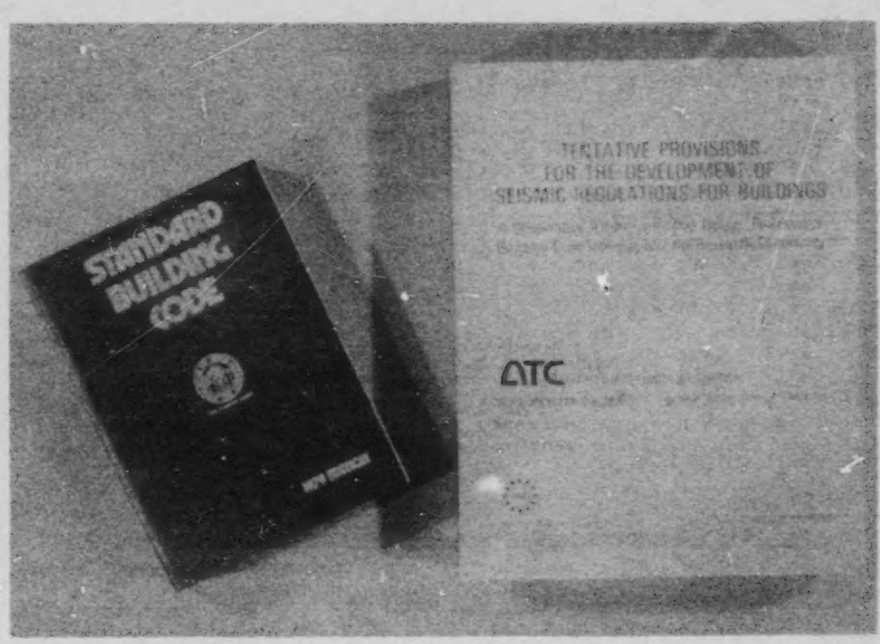

STANDARD BUILDING CODE
TENTATIVE PROVISIONS FOR THE DEVELOPMENT OF SEISMIC REGULATIONS FOR BUILDINGS
ATC

Figure 13

region. However, this group must have more broad responsibilities. It must encourage and coordinate the development largely by the southeastern regional technical community of technology addressing unique regional needs. The TTDG would be supported by technology transfer associates, Dr. Mihran Agbabian of Agbabian Associates and Mr. H. J. Degenkolb of H. J. Degenkolb Associate Engineers, both of California.

3.4 Seismic Upgrade of Existing Buildings

Seismic strengthening is largely ignored in the restoration of old and historic buildings throughout the southeastern United States. This is of particular concern since the buildings are largely of masonry unreinforced construction and were of little seismic strength even when constructed decades ago. Due to age and weathering, they are even more inadequate today. Figure 14 is a photograph of some such old buildings in Charleston, South Carolina. As shown in The walls are commonly only stuccoed during restoration. No significant strengthening is usually achieved. Figure 15 shows the exposed wood roof truss of a neaby building undergoing renovation. Careful examination reveals no incorporation of seismic upgrading measures such as the structural connection of the truss chords to the masonry wall sections in the lateral direction. Figure 16 is a photograph of some historical buildings which have been "restored" in this manner. Certainly, they are attractive, appear substantial and give little indication of their significant seismic weaknesses. Builders, developers, the public and regional engineers need to be instructed in the economically feasible seismic strengthing measures possible within available technology that are consistent with their historic character. Certainly, historic buildings can be seismically strengthened without compromise of their historic character. Certainly, they must be. Otherwise, the public is deceived into assuming these often compromised facilities are stable for years of safe future service. The correction of this condition can be encouraged through the federal historic restoration agencies that administer tax credits to those restoring such historic buildings. In review processes, compliance with applicable federal seismic upgrade provisions should be made prerequisite to tax credit allowances just as the more superficial aspects are mandated today. It seems unreasonable that some agencies of federal government fully understand the means and imperative need to strengthen such old buildings while other federal agencies freely administer such government subsidized restorations without dictating such precautions. In any event, procedures like that developed in Los Angeles for the practical seismic strengthening of old unreinforced masonry buildings have not yet been introduced and adopted in the southeast. The need is imperative.

There is some evidence of increasing awareness and commitment to good design practice. A multi-story motel complex under construction in North Charleston, South Carolina, provides a good example. Construction was halted when a design review revealed the structure was inadequate for prescribed seismic loads. Figure 17 shows this motel at that time. Despite the considerable cost and delay

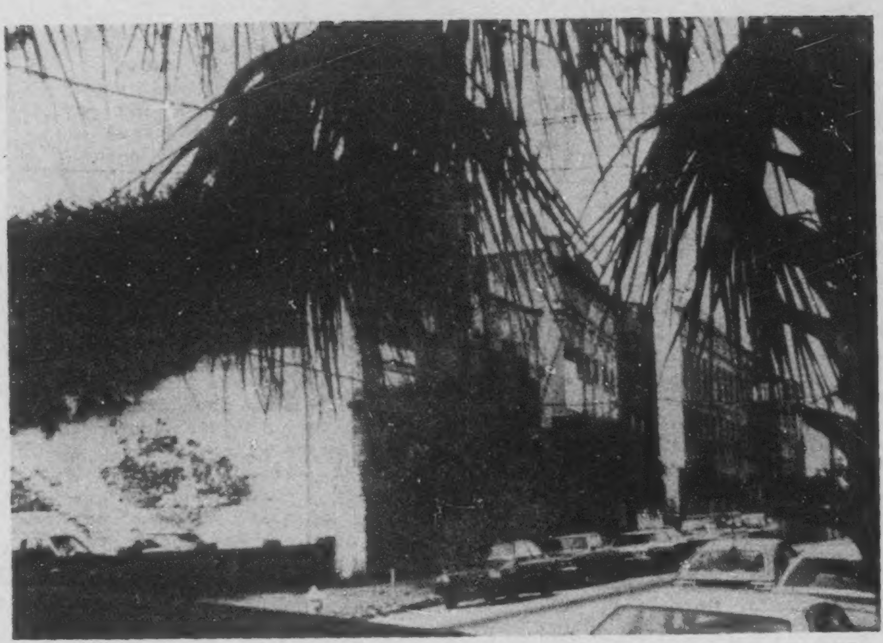


Figure 14

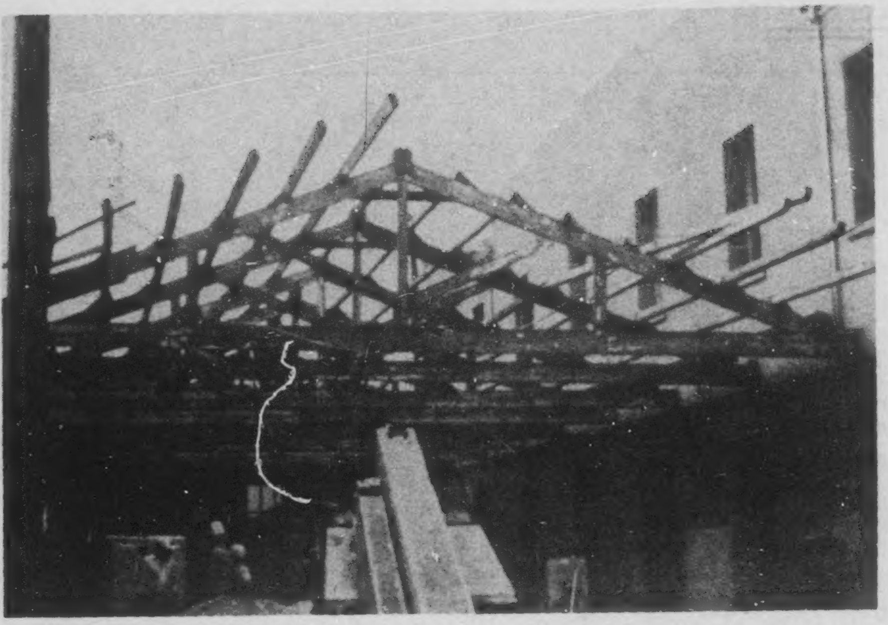


Figure 15

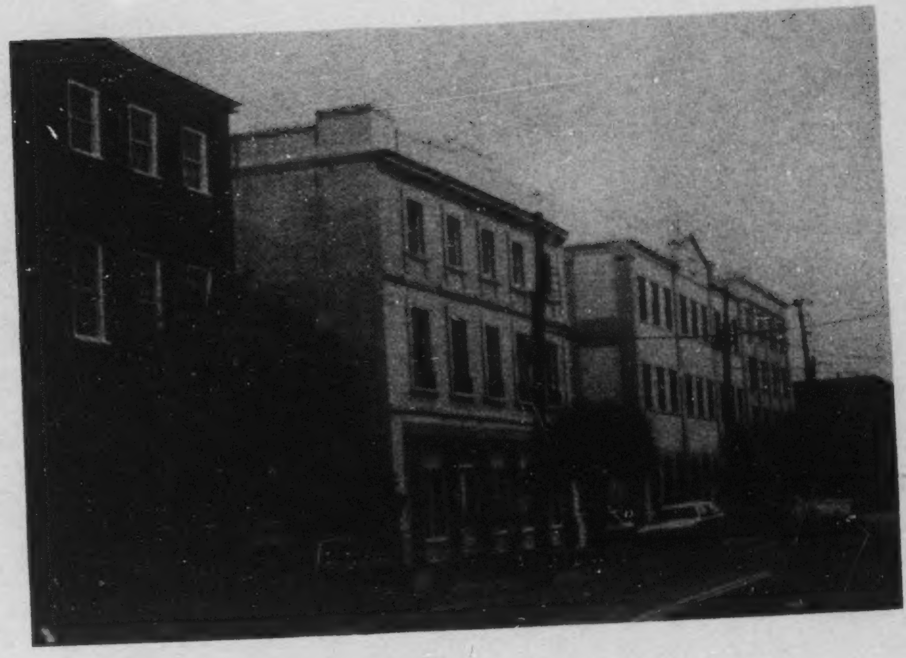


Figure 16

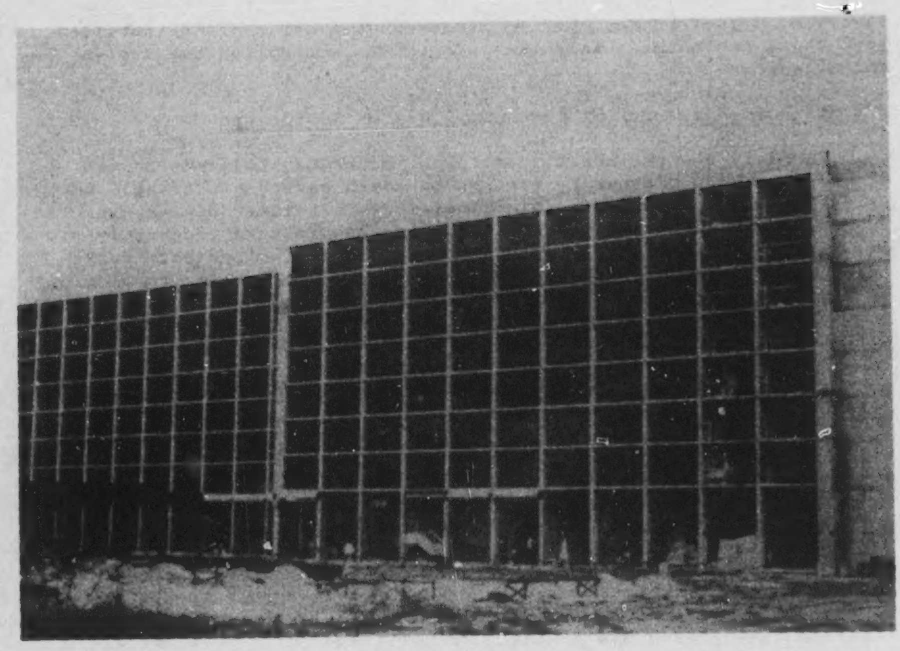


Figure 17

involved, seismic strengthening measures were defined and installed. A west coast engineering firm was selected to accomplish the design modifications.

3.5 Demostration of Technical Design Proficiency

Very few engineers practicing in the Southeastern United States have been adequately trained in earthquake engineering. No professional engineering examinations include seismic design exercises. These professional certifcation processes should more adequately protect the public welfare. Tests should be revised to include earthquake engineering principles and procedures. In the meanwhile, completion of an appropriate prescribed short course in seismic design should be required to promote technical sufficiency. Both restrictions are employed among the western states.

3.6 American Society of Civil Engineers Acceptance of Seismic Safety Responsibilities

Civil engineers are largely responsible for the public's environment and, hence, seismic safety. Civil engineers rightfully played a leadership role in the development of Massachusetts's seismic safety code, the only such state code in the eastern United States. Members of the southeastern United States Seismic Safety Consortium are acting to encourage southern civil engineering state sections to form seismic safety technical groups and assume a lead role in advancing state policy. South Carolina and Georgia Civil Engineers have recently accepted these responsibilities. Missouri and North Carolina Civil Engineers are beginning to take these initiatives.

IV. Conclusions

The major accomplishments in earthquake hazard reduction and mitigation achieved under the provisions of National Earthquake Hazard Reduction Program have not yet materially benefited the southeastern United States. Seismic safety developments remain those common to California several decades ago. This situation is particularly critical to the public in the southeasten region as there is as great a potential of earthquakes to kill and damage in the southeastern United States as there is in Southern California and parts of other western states. While western earthquakes occur more frequently, it is apparent that the far greater destructive capability of eastern earthquakes ranks the southeastern seismic hazard with that of the more notorious western national region.

Significant effort is required to meet the grave seismic hazards facing the southeastern communites. A concerted program has been launched by the Southeastern United Statess Seismic Safety Consortium in concert with the South Carolina Seismic Safety consortium to bring the southeastern region abreast of California and other leading western states in regard to effective earthquake hazard reduction and mitigation. This effort will require considerable commitment of time and resources, including that of the federal government. However, the dire risk to the safety of our public leaves no responsible alternatives to the patient seismic safety revolution now in progress. The full support is necessary of the National Science Foundation, United States Geological Survey, Federal Emergency Management Agency, the United States Nuclear Regulatory Agency and the National Bureau of Standards (Center for Building Technology). The program demands are broad and involve the specific specialized responsibilities of each of these agencies. With this essential assistance and that of our considerate colleagues in the western regions, reasonable levels of seismic safety can be and must be achieved in the Southeastern United States.

APPENDIX A

TASK GROUP RESPONSIBILITIES

TENTATIVE OBJECTIVES
HAZARD AWARENESS & PUBLIC INFORMATION TASK GROUP

1. Collect all available information that defines the earthquake hazards and the risk within the Southeastern United Staes with emphasis on the South Carolina lowcountry region. Risk should be stated in the context of all hazards to provide perspective.

2. Synthesize information into one or more packages that can be released to public officials, the media, business and industry, design professionals and the research community.

3. Seek advice and information from other groups that have relevant experience, such as California Seismic Safety commission, Utah Seismic Safety Advisory Council, Earthquake Emergency Management Agency, the U.S. Geological Survey and the Geological Survey's of South Carolina, Georgia, Virginia and North Carolina.

TENTATIVE OBJECTIVES
PUBLIC SECTOR PARTICIPATION TASK GROUP

1. Identify all local, state and regional institutions and organizations that might have an interest in earthquake preparedness, perhaps in conjunction with an all hazards preparedness program.

2. Form subcommittees to enlist and to involve these institutions and organizations.

3. Provide hazard awareness information through these subcommittees and develop an "outreach" program.

4. Identify and cultivate possible political sponsors; provide specific information to them to increase their hazard awareness.

TENTATIVE OBJECTIVES
RESPONSE TO A DAMAGING EARTHQUAKE TASK GROUP

1. Evaluate existing emergency response plans of local, state and federal governments as to their adequacy and currentness with respect to seismic safety policy.

2. Provide the best available information about earthquake hazards in South Carolina and the Southeastern United States to the appropriate emergency preparedness agencies. The information should be synthesized and packaged in a format that is most useful--perhaps in all hazards perspective, so that existing plans can be updated as required.

3. Coordinate local, state and federal government emergency response plans with respect to seismic safety.

4. Sponsor workshops, conferences and training sessions to develop and to exercise earthquake response plans.

5. Introduce needed legislation. This includes preparation to take advantage of a damaging earthquake to introduce such needed legislation.

TENTATIVE OBJECTIVES
INTERGOVERNMENTAL RELATIONS AND COOPERATION

1. Establish interpersonal communication networks and liaison with governmental organizations who are involved in seismic safety policy.

2. Interact with governmental organizations to build a seismic safety policy; interchange information about earthquake hazards and risk that have been cast into an all hazards perspective.

3. Identify manufacturers and users of hazardous materials (toxic, flammable, etc.) that might be vulnerable to damaging earthquakes; provide information to these groups and encourage them to take preparedness measures consistent with the seismic safety policy.

4. Draft model legislation to address specific issues in earthquake hazards mitigation and response and recovery.

5. Provide precise information to emergency management agencies of local, state and federal government and cooperate with them to develop response plans.

6. Identify the gaps in knowledge that affect seismic safety policy in the Southeastern United States including South Carolina and take steps to eliminate them.

7. Establish cooperative efforts with appropriate agencies of local, state and federal governments, business and industry, design professions and the research community to improve earthquake hazards reduction and response and recovery planning.

8. Evaluate and accomplish the organizational structure of SEUSSSC and SCSSC at appropriate points in time to determine its effectiveness and the need for change.

TENTATIVE OBJECTIVES
LOCAL EARTHQUAKE - RESISTANT DESIGN TASK GROUP

1. Work through building code groups, professional organizations, state and local legislative bodies, and others to evolve a seismic safety policy that will lead to the requirement of seismic desgin provisions in new existing buildings of local, state and federal governments located in South Carolina and the southeastern United States.

2. Provide training for local building officials to enforce the seismic safety requirements.

3. Establish local despository of scientific and engineering information concerning the earthquake hazards and mitigation measures.

4. Influence federal and other earthquake engineering research and design development to insure unique technology needs of South Carolina and the southeastern United States are effectively met through responsive, prioritized and integrated measures.

5. Promote development and continuing education in earthquake-resistant design (perhaps in the context of multi-protection design concepts) through universities, Earthquake Engineering Research Institute, the Federal Emergency Management Agency, and other organizations.

6. Develop data and procedures for (a) reviewing the earthquake resistance of existing buildings and (b) balancing the increased cost of more resistant construction against the risk of losses during future earthquakes.

7. Develop a procedure for reviewing the earthquake resistance of existing and planned critical facilities (i.e., nuclear power plants, dams, hospitals).

APPENDIX B

DAMAGE AND GROUND MOTION LEVELS FOR VARIOUS MODIFIED MERCALI INTENSITIES

DAMAGE AND GROUND MOTION LEVELS

MMI	TYPICAL BUILDING DAMAGE	HORIZONTAL PEAK ACCELERATION (GRAVITY)
VI	DAMAGE SLIGHT IN POORLY BUILT STRUCTURES, NEGLIGIBLE IN WELL-BUILT STRUCTURES	0.05 - 0.10G
VIII	DAMAGE CONSIDERABLE IN SUBSTANTIAL BUILDINGS, SLIGHT FOR EARTHQUAKE REINFORCED BUILDINGS	0.20 - 0.35G
X	SEVERE DAMAGE TO MOST STRUCTURES, INCLUDING WELL-REINFORCED BUILDINGS	0.50G+

APPENDIX D

SOME NEWSPAPER ACCOUNTS OF PUBLIC INTEREST IN SEISMIC HAZARDS

10/22/82 Charlotte Observer

Quake Prediction

Eastern U.S. Due For Big One This Generation, Engineer Says

Associated Press

RALEIGH — Chances are high that a powerful earthquake will hit somewhere in the eastern United States "during your present generation," an engineer warns.

Lt. Col. Charles Lindbergh, a civil engineer and member of the United States Seismic Safety Consortium, made the prediction this week during an "earthquake fundamentals" conference at N.C. State University.

At the same conference, a professor of geophysics, said that such a quake probably would be more severe than those experienced in recent decades on the West Coast.

According to Lindbergh, a "white paper" to be released by the consortium next month reads: "There is sufficient likelihood that a major earthquake will occur in the Eastern United States and very possibly in the Southeastern United States during your present generation."

Lindbergh, a distant relative of the famous aviator with the same name, heads the civil engineering department at The Citadel, a Charleston, military school.

The safety consortium was formed to make the region's inhabitants more aware of the possibility of earthquakes, he said.

Dr. G.A. Bollinger, a geophysics professor at Virginia Polytechnic and State University in Blacksburg, Va., joined Lindbergh in addressing about 100 engineers and other specialists at the conference.

"There are fewer earthquakes (in the East than in the West), but the damage areas are 10 times or more larger," Bollinger said. "The damage is tied up in the physical properties of crustal rocks."

Lindbergh agreed, quoting Dr. Otto W. Nuttli, an earthquake specialist at St. Louis University: "When the next major earthquake occurs in the East, it will produce a disaster of unprecedented scale."

Lindbergy recalled that the largest two earthquakes that occurred in the United States in recorded history were in Charleston, in 1886 and New Madrid, Mo., around 1811.

If a similar quake occurred today, it would cause "almost total destruction" in a 5,100-square-mile ring around the epicenter, Lindbergh said.

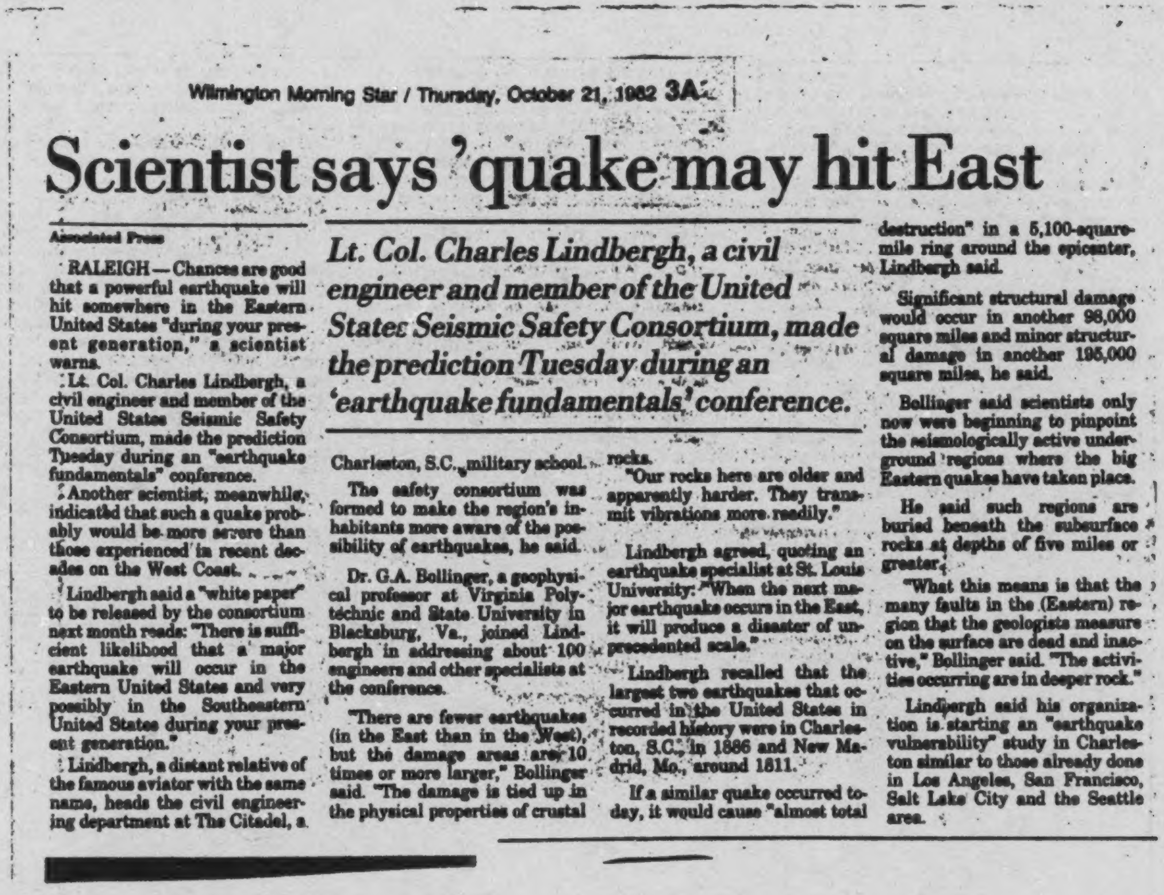
Significant structural damage would occur in another 98,000 square miles and minor structural damage in another 195,000 square miles, he said.

Bollinger said scientists only now were beginning to pinpoint the seismologically active underground regions where the big Eastern quakes have taken place.

He said such regions are buried beneath the subsurface rocks at depths of five miles or greater.

"What this means is that the many faults in the (Eastern) region that the geologists measure on the surface are dead and inactive," Bollinger said. "The activities occurring are in deeper rock."

Lindbergh said his organization was starting an "earthquake vulnerability" study in Charleston similar to those already done in Los Angeles, San Francisco, Salt Lake City and the Seattle area.



Wilmington Morning Star / Thursday, October 21, 1982 3A

Scientist says 'quake may hit East

Associated Press

RALEIGH — Chances are good that a powerful earthquake will hit somewhere in the Eastern United States "during your present generation," a scientist warns.

Lt. Col. Charles Lindbergh, a civil engineer and member of the United States Seismic Safety Consortium, made the prediction Tuesday during an "earthquake fundamentals" conference.

Another scientist, meanwhile, indicated that such a quake probably would be more severe than those experienced in recent decades on the West Coast.

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"There are fewer earthquakes (in the East than in the West), but the damage areas are 10 times or more larger," Bollinger said. "The damage is tied up in the physical properties of crustal rocks.

"Our rocks here are older and apparently harder. They transmit vibrations more readily."

Lindbergh agreed, quoting an earthquake specialist at St. Louis University: "When the next major earthquake occurs in the East, it will produce a disaster of unprecedented scale."

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2-A—The News & Courier, Charleston, S.C., Tuesday, Nov. 16, 1982

State Not Prepared To Cope With Quake, Scientists Say

By BILL KOVARIK
Post-Courier Reporter

A group of scientists warned Monday that South Carolina is "not prepared to cope" with an earthquake of any size.

A report on earthquakes was issued Monday by the South Carolina Seismic Safety Consortium, which is holding a seismic safety planning workshop Monday and today at the Baptist College at Charleston.

According to the report, an earthquake of 5 points on the Richter scale could be expected within 10 years in the state, while an earthquake of 6 point magnitude could be expected within 100 years.

The earthquake that leveled most of Charleston in 1866 was estimated at 8 points on the scale, but quakes of that size have been so infrequent as to make probability estimates impossible, the scientists said.

"When the next major earthquake occurs in the east, it will produce a disaster of unprecedented scale," O.W. Nuttli of St. Louis University said in the report.

"We're not crying Chicken Little," said Dr. Charles Lindbergh of The Citadel's Department of Civil Engineering. "We're trying to be as calculated about it as we can." Lindbergh is a co-chairman of the seismic safety consortium, as is Baptist College's Joyce B. Bagwell.

The report "soberly acknowledges" that neither the state nor the southeast region "is prepared to cope with the social and economic impacts of any damaging earthquake, much less one of such devastation as would be caused by a recurrence of the 1886 quake."

See Scientists, Page 2-A

...Scientists On Quake

Continued From Page 1-A

The earthquake of Aug. 31, 1886, killed 76 people and left most of Charleston devastated. The quake was one of the largest to have occurred in North America.

Delbert Ward, formerly the director of Utah's Seismic Safety Advisory Council, warned, "You do have a historical record of earthquakes in Charleston ... There is risk here."

Ward also noted that, in a major earthquake, water, power and telephone lines would be damaged, and that firefighting services might not be available.

The scientists at the workshop said earthquakes in the eastern U.S. were less frequent and less severe than those in the west.

But since earthquakes are seen as more of a threat in the west, trying to assess their likelihood and taking steps to be prepared is all the more difficult in the east.

Lindbergh stressed the need for a wide spectrum of design ideas to improve seismic safety, especially in building codes. "Most historical buildings (in Charleston) have very little seismic strength," Lindbergh said. "We feel they should be strengthened."

Standards for new buildings also need to be upgraded, scientists agreed. Most buildings in Charleston are built with general design specifications, but integrating hurricane-resistant and earthquake-resistant building codes would be an improvement, Lindbergh said.

Lindbergh said the consortium is at work on a 5-year vulnerability study to assess risks in a variety of situations, to inventory critical facilities that would be affected, and to make recommendations on what to do.

The study, which will be the first on the east coast, was funded through a $41,000 Federal Emergency Management Agency grant.

Thomas L. Hansen, director of the Berkeley-Charleston-Dorchester Council of Governments, said that while people in the area are aware that earthquakes could occur at any time, "I do not believe that they are aware of either the possible damages that could occur as a result of a major episode, or of what may be done to mitigate damages."

State Not Prepared To Cope With Quake, Scientists Say

By BILL KOVARIK
Post-Courier Reporter

A group of scientists warned Monday that South Carolina is "not prepared to cope" with an earthquake of any size.

A report on earthquakes was issued Monday by the South Carolina Seismic Safety Consortium, which is holding a seismic safety planning workshop Monday and today at the Baptist College at Charleston.

According to the report, an earthquake of 5 points on the Richter scale could be expected within 10 years in the state, while an earthquake of 6 point magnitude could be expected within 100 years.

The earthquake that leveled most of Charleston in 1886 was estimated at 8 points on the scale, but quakes of that size have been so infrequent as to make probability estimates impossible, the scientists said.

"When the next major earthquake occurs in the east, it will produce a disaster of unprecedented scale," O.W. Nuttli of St. Louis University said in the report.

"We're not crying Chicken Little," said Dr. Charles Lindbergh of The Citadel's Department of Civil Engineering. "We're trying to be as calculated about it as we can." Lindbergh is a co-chairman of the seismic safety consortium, as is Baptist College's Joyce B. Bagwell.

The report "soberly acknowledges" that neither the state nor the southeast region "is prepared to cope with the social and economic impacts of any damaging earthquake, much less one of such devastation as would be caused by a recurrence of the 1886 quake."

See Scientists, Page 2-A

...Scientists On Quake

Continued From Page 1-A

The earthquake of Aug. 31, 1886, killed 76 people and left most of Charleston devastated. The quake was one of the largest to have occurred in North America.

Delbert Ward, formerly the director of Utah's Seismic Safety Advisory Council, warned, "You do have a historical record of earthquakes in Charleston ... There is risk here."

Ward also noted that, in a major earthquake, water, power and telephone lines would be damaged, and that firefighting services might not be available.

The scientists at the workshop said earthquakes in the eastern U.S. were less frequent and less severe than those in the west.

But since earthquakes are seen as more of a threat in the west, trying to assess their likelihood and taking steps to be prepared is all the more difficult in the east.

Lindbergh stressed the need for a wide spectrum of design ideas to improve seismic safety, especially in building codes. "Most historical buildings (in Charleston) have very little seismic strength," Lindbergh said. "We feel they should be strengthened."

Standards for new buildings also need to be upgraded, scientists agreed. Most buildings in Charleston are built with general design specifications, but integrating hurricane-resistant and earthquake-resistant building codes would be an improvement, Lindbergh said.

Lindbergh said the consortium is at work on a 5-year vulnerability study to assess risks in a variety of situations, to inventory critical facilities that would be affected, and to make recommendations on what to do.

The study, which will be the first on the east coast, was funded through a $41,000 Federal Emergency Management Agency grant.

Thomas L. Hansen, director of the Berkeley-Charleston-Dorchester Council of Governments, said that while people in the area are aware that earthquakes could occur at any time, "I do not believe that they are aware of either the possible damages that could occur as a result of a major episode, or of what may be done to mitigate damages."

11/12/82

The Greenville News

STATE/REGION

Charleston's chances of quake studied

CHARLESTON (UPI) — When Col Maurice R. Harlan and several senior engineering students at The Citadel begin an inventory of essential facilities in the area soon, they won't just be counting buildings.

Harlan is the principal investigator of a federally funded study analyzing Charleston's vulnerability to another serious earthquake. The 1886 earthquake killed 27 people and virtually destroyed the city, causing an estimated $5 million to $6 million worth of damage.

"We will be postulating the magnitude of an earthquake that reasonably could be expected to occur and assessing the probable damage it would cause," the civil engineering professor said Wednesday.

The worst-case scenario will be developed over 15 months at a cost of $41,000 provided by the Federal Emergency Management Agency.

The analysis will be given to local and state organizations to help them design comprehensive disaster relief plans and recovery operations to improve emergency preparedness.

While similar studies have been conducted for four West Coast cities and six metropolitan areas in the Midwest, this will be the first analysis of a city in the Southeastern United States, Harlan said.

The study will serve as a prototype for vulnerability analyses of other cities in the state and region, he said.

Harlan said the inventory will include medical resources, public structures, communications, transportation systems, public utilities and schools.

Estimates will be made of casualties, structural damage and the loss of vital public needs.

Harlan said a similar inventory was conducted after the 1886 earthquake by two people hired by an insurance company.

They examined some 7,000 buildings and produced the most comprehensive record up to that time of earthquake damage, he said.

"On the modified Mercalli intensity scale, the Charleston quake was a 10," said Harlan.

The scale ranks the intensity of earthquakes upward from one to 12.

Charleston could experience an earthquake again of the equivalent to the one in 1886, which was felt as far away as Massachusetts, Wisconsin and Bermuda, he said.

Charleston is believed to lie along the so-called Woodstock fault which extends from the Appalachian Mountains to the coast. The fault's exact location never has been found.

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;oing well but officials expressed

See GEMAYEL, page 8A

chairman.

The four separate functions,

See REAGAN, page 8A

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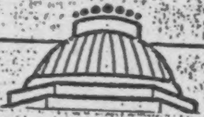
The News and Observer

', October 20, 1982

Main Number 829-4500 Classified 829-4600 Circulation 829-4700

Daily 25c,

Under the dome



in the race, and he has refused
give Marin the exposure of a
ublic debate.

Marin's latest try is a letter to
alentine in which he makes a for-
al appeal for the match-up on
rounds that Valentine's refusal to

ance in Roxboro two weeks ago, Marin watched Valentine leave the room when it became the Republican's turn to speak.

Valentine has dismissed a de-

See DOME, page 8A

FBI says he tried to aid firm

DeLorean held in drug case

to distribute cocaine and posses-sion of cocaine with intent to distribute. The FBI said 60 pounds of cocaine worth $6.5 million was seized Monday when the other two men were arrested. Police did not say if they knew the whereabouts of the remaining cocaine allegedly

produce quickly large sums of money in return for the investments. ... His company is in severe financial problems, and he feared the possibility of his company being closed down by the (British) government, which had ex-

four years ago. He won $143 m
lion in British government gran
and loans to help set up his au
plant at Belfast. The company pr
duced a $25,000 sports car disti

See DeLOREAN, page 8A

Experts warn next big earthquake could be in East

By MONTE BASGALL
Staff Writer

While Western states generally
re considered earthquake coun-
y, the East should weigh the pos-
bility that the next Really Big
ne will be here, participants at
n "earthquake fundamentals"
onference warned Tuesday.

Because they affect far larger
reas, quakes in Charleston, S.C.,
1886 and New Madrid, Mo., in
311-12 actually were "the largest
hat have occurred in our coun-
y," said Lt. Col. Charles Lind-
ergh, a civil engineer.

Dr. G.A. Bollinger said: "There
re fewer earthquakes (in the
ast), but the damage areas are 10 times or more larger. The damage is tied up in the physical properties of crustal rocks. Our rocks here are older and apparently harder. They transmit vibrations more readily."

A "white paper" to be released next month by the Southeastern United States Seismic Safety Consortium, of which Lindbergh is a member, brings the matter home: "There is sufficient likelihood that a major earthquake will occur in the Eastern United States and very possibly in the Southeastern United States during your present generation."

Lindbergh, a distant relative of the famous aviator, heads the civil engineering department at The Citadel, the Charleston military college. He also is a member of the safety consortium, which was formed to make the region's inhabitants more quake-conscious and is one of the co-sponsors of the conference held Monday and Tuesday at N.C. State University.

Bollinger is a geophysics professor at Virginia Polytechnic and State University in Blacksburg, Va., and a leading investigator of Eastern earthquakes, which scientists think originate at far greater depths than their Western counterparts.

Both were interviewed by telephone after they had addressed about 100 engineers and other specialists from as far away as Syracuse, N.Y.

Lindbergh also quoted a warning by Dr. Otto W. Nuttli, an earthquake expert at St. Louis University. "When the next major earthquake occurs in the East, it will produce a disaster of unprecedented scale."

According to Nuttli's figures, if a Charleston- or New Madrid-sized quake occurred today, it would cause "almost total destruction" in a 5,100-square-mile ring around the epicenter, Lindbergh said.

Significant structural damage would occur in another 98,000 square miles and minor structural damage in another 195,000 squa
miles.

Bollinger said the New Madr
and Charleston quakes broke wi
dows and cracked plaster a
foundations in Raleigh, besid
frightening residents. "It was n
nor damage but pretty serious if
was your home," he said.

He compared the intensity of t
New Madrid quake to that in S
Francisco in 1906. Charlestor
was smaller, approximating a 19
quake in the San Fernando Vall
But, because of Eastern geologic
conditions, damaging vibratio
affect larger areas than in t

See NEXT, page 9A

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Next big earthquake could be in East

Continued from page 1A

West.

Bollinger said that scientists only now were beginning to pinpoint the seismologically active underground regions where the big Eastern quakes have occurred.

"They are buried deep in subsurface rocks at depths of five miles or greater," he said. "That is different from California earthquake faults, which are visible at the surface. Historically, earthquakes in the East have no record of breaking the ground."

"What this means is that the many faults in the (Eastern) region that that geologists measure on the surface are dead and inactive. The activities occurring are in deeper rock."

Because Eastern earthquakes occur about six or seven times less frequently, predicting when or where the next one will occur is an even less exact science than spotting active Eastern faults.

Recently deployed instruments measuring the subtlest shakes have shown that sites of past earthquakes remain active. But there are also surprises, such as a 1980 tremblor that shook north central Kentucky.

"While we feel places of known larger events are likely candidates, we can't with the present state of knowledge rule out other locales," Bollinger said. In addition to Charleston, New Madrid and Boston — the site of another past quake — scientists consider Appalachian areas worth watching, he said.

Lindbergh said his consortium was starting an "earthquake vulnerability" study in Charleston similar to those already done in Los Angeles, San Francisco, Salt Lake City and the Seattle area.

A nuclear power plant engineer said that, while he's convinced that U.S. reactors are built to resist even severe earthquakes, other "critical facilities" — including dams and chemical plants — may be in more danger.

"Nuclear power plants are built with very large earthquakes in mind," John D. Stevenson said before his Tuesday afternoon talk. "Some hazardous chemical facilities are not built that way. I guess I would worry about some dams."

Stevenson, president of Stevenson and Associates, a consulting engineering firm in Cleveland, Ohio, called for a general review of the earthquake safety at such facilities.

"My personal feeling is that there should be a review similar to what they had for hazardous waste," he said.

Other sponsors of the conference included the Earthquake Engineering Research Institute of Berkeley, Calif. Co-sponsors included NCSU, Duke Power Co. and professional organizations of engineers, civil engineers, mechanical engineers and contractors.

Quake felt in California

MENLO PARK, Calif. (UPI) — An earthquake registering 3.3 on the Richter scale, centered on the San Andreas fault near Gilroy, shook an area five miles northeast of Watsonville Tuesday, near Mount Madonna, the U.S. Geological Survey reported.

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Mr. **Brown**. Thank you very much, Dr. Lindbergh.

Mr. Dymally, do you have questions?

Mr. **Dymally**. No, Mr. Chairman.

Mr. **Brown**. Dr. Lindbergh, I am concerned about your point there about the limited impact of the national program. We have fought from the very beginning to make it clear that the Earthquake Hazard Reduction Act was a national program. Although we may argue that the expenditure of funds, which has predominantly been in the West and in California, is contributing to the expanding of the base of knowledge that will benefit the rest of the country, the many components of the program need to be applied in all parts of the United States.

I would like to ask you to comment on whether you feel that there are sufficient efforts being made in this direction toward making sure that the application of the program is being extended and that there is reasonable hope that you will get benefit from that program in the Southeast.

Dr. **Lindbergh**. Sir, I am very happy to say that I believe there is great potential and willingness now to effect the full realization of the accrued technology, in that we in the Southeastern United States do now have the interested, involved infrastructure. We are also well aware that we have the National Science Foundation, the U.S. Geological Survey, FEMA, and our counterparts in the other States who are very willing now to focus energies and efforts toward the situation in the Southeastern United States.

I am very happy to see the displayed willingness, and all I can say is that the need is urgent, sir, to press ahead in that direction.

Mr. **Brown**. I would compliment you on your presentation. The pictures are worth words.

The only thing that I can compare that to is the pictures that I have seen of the San Francisco earthquake of 1906.

There is no better way to get across the imminence of the hazard than to show your pictures, which are equally serious, I think.

It is rather interesting that it is almost routine on the part of an agency such as the Corps of Engineers to design for a 100-year or even 200-year hazards in terms of flooding damage, for example. However, we do not seem to become accustomed to that idea in other areas of hazards, such as earthquakes.

Dr. **Lindbergh**. Sir, that is exactly what Congressman Hartnett told me this morning. That is exactly the same point.

Mr. **Brown**. Well, it shows that we need something comparable to the Corps of Engineers in the earthquake field, doesn't it?

I would like to ask each of you gentlemen to comment on the testimony of the last panel that indicated some concern about the possible loss of momentum in the earthquake program as a result of the reductions in funding contemplated in the budget.

I think you all understand, because of the experience in your own States as well as the Federal Government, that money is not easy to come by, but what is your view with regard to the possible adverse effects of reductions that we are seeing here?

Dr. **Andrews**. I would only echo, Mr. Chairman, the comments of Dr. Allen regarding the loss of momentum and cite one example.

There has been a considerable amount of discussion regarding the Japanese and Chinese prediction efforts. In the case of the Japanese, their earthquake database, if you will, begins in the area where they are now attempting to predict the earthquake in 684 A.D., and it is pretty much a continuous record. One of the obvious major problems we have in California and in the United States is that we do not have that kind of historical record. Even a temporary interruption in the building of the database is something that I think will have long-term, rippling, adverse effects on the entire program. Therefore, I think it is essential that these basic research programs proceed, if at all possible, in an uninterrupted way.

Mr. **Brown**. Do you have any comments, Dr. Lindbergh?

Dr. **Lindbergh**. Yes, sir, I certainly do.

Sir, we talk about losing momentum. Again, in our area we have not established the momentum to be lost. It is very key to us, and to the public safety in our area, to say nothing about national defense and the other aspects involved, that at this time we focus these sufficient resources. Instead of reducing the allocation of them, let us at least take what would be the reduction and apply it to not China or the others, but the Southeastern United States and help us, if you will, acquire momentum.

I think it would be a very inappropriate time to reduce the resources, just at the time when our national technology base has at least reached a minimum level that should now be translated throughout the Nation, as the act that you well described, sir, intended it to be, as we still maintain the momentum for further appropriate goals in the West or in the other technology areas.

I think, sir, that it is highly inappropriate at this time, and I honestly believe that it would be dereliction in obligation to our public.

Mr. **Brown**. That is a very strong statement.

Do you have any questions, Mr. MacKay?

Mr. **MacKay**. I am from Florida and have some familiarity with South Carolina. I confess I had not been aware that you had that in the history of the Charleston area.

Are there known faults—I am sure there are—known fault lines where you can actually evaluate the potential for earthquake activity?

Dr. **Lindbergh**. That is an interesting point. Here, again, that is another difference. In the West there are distinctive faults; in the East we are still looking for the ones that resulted in the one in Charleston.

Dr. Nuttli could address this much better than I can, but there are no pronounced faults that I know of, surface faults anyway, associated with that in the East. It is a wider distribution, if you will, of energy release.

Mr. **Brown**. Gentlemen, I have no further questions at this point, but I have been very much impressed with your testimony. I want you to be aware of that. It has made a great contribution to our hearing.

Of course, this subcommittee has taken a major interest in this area for a number of years. We will try to keep the program going, just speaking for the subcommittee, at the best level that is possible. Of course, the Congress has many voices in it, and we are not always sure what we can accomplish. However, we will keep as much effort behind this as we can.

Thank you very much for your testimony.

Dr. **Andrews**. Thank you.

Dr. **Lindbergh**. Thank you.

Mr. **Brown**. The subcommittee will be adjourned.

[Whereupon, at 4:14 p.m., the subcommittee adjourned, to reconvene at the call of the Chair.]

FEDERAL FIRE PREVENTION AND CONTROL ACT AUTHORIZATION

WEDNESDAY, MARCH 16, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research, and Technology,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:20 a.m., in room 2325, Rayburn House Office Building, Hon. Harry M. Reid (acting chairman of the subcommittee) presiding.

Present: Representatives Walgren, Reid, MacKay, Brown, McCurdy, Gregg, Skeen, Sensenbrenner, Boehlert, McGrath, and Bateman.

Staff present: Dr. Thomas Kramer, staff director; Carrye Brown, research assistant; and Maryanne C. Bach, minority technical consultant.

Mr. **Reid**. This subcommittee will come to order. On the agenda today is the authorization hearing on the Federal Fire Prevention and Control Act of 1974. I would, however, like to give a statement.

Gentlemen, in February 1981, a demented man set a fire that would rage for over a day, some 25 hours. The fire occurred in Las Vegas, Nev. Almost 600 firemen and police would be on duty trying to coordinate uncounted hundreds of volunteers that also were trying to help in the effort.

It was a spectacular fire on the eighth floor of the largest hotel in the world. The live television coverage recorded for all the world to see the unique heroism of firemen and volunteers. This fire killed 10 people, about 350 were injured. Estimated structural damage was $12.9 million; and totals estimated damage is probably $130 million. That fire was at the Las Vegas Hilton Hotel. A fire that touched everyone in my hometown in a horrifying way that it affected the entire tourist industry. The arsonist did not know that at the moment he torched that fire he triggered into operation a professional team that was created as a result of the Federal Fire Prevention and Control Act of 1974.

Las Vegas had had some background in fires because just a short time prior to that another fire, allegedly caused by construction defects, killed some 85 people; injured 700; with hundreds of millions of dollars in lost property and other things.

The Federal Arson Task Force, as it relates to the Hilton fire, which is a combination of Federal and local personnel, arrested the arsonist in less than 20 hours. The national fire data bank helped identify the arsonist.

A local fire chief is convinced that the arsonist would have struck again had he not been apprehended. The Federal task force averted another tragedy in Las Vegas by their swift and professional skills. Personnel from the National Bureau of Standards Center for Fire Research were on site immediately. Their work helped convict the arsonist. He was not only arrested but convicted. We know from reading all the accounts in the literature that the conviction of arsonists is something that is quite rare. They supplied invaluable aid in helping the Nevada Legislature, thereafter, develop a retrofitting law that is a model to our Nation. To suggest a reduction or elimination of any part of the Center for Fire Research is to be insensitive, in my opinion, to human suffering. A failure to see a dollar spent here saves hundreds of lives and millions of dollars. In this fire, swift and professional action saved hundreds of lives and probably enough money to fund the entire agency for a year. This is one dramatic example of the positive results of the Center for Fire Research and its various components.

My concern is not the dramatic example but the continuing improvement of fire protection for my family, my State, and certainly the country.

My district has 5 public fire departments and 12 volunteer units. Statistics from just one of those departments show the alarming price we pay for not making a national effort to control fire and arrest arsonists.

In 1982, 2,455 fires resulted in about $10 million in damage. Half of that damage in single-family residences. The alarming statistics is the arson rate: some say half the fires. One police chief in Las Vegas estimates 70 percent of the fires set in Las Vegas, are by arsonists. This is not high by national standards according to many people, including insurance companies. The FBI list arson as the fastest growing crime in America. The people looking at organized crime know that organized crime is moving into this field more rapidly than any other. It is one of the most lucrative areas for the criminal to be involved.

My district, the State, and certainly the Nation, depend on the services of this agency to help our local firefighters protect the lives of my family and friends. The Federal task force has an impressive record in my district with a conviction rate of over 75 percent. The national average, I understand, is about 70 percent. The National Fire Academy has trained approximately 30 firemen in my area. I, like all members of the subcommittee today, have been given a list of those people from our States and districts who have attended this Academy. An invaluable service when over three-quarters of our firefighters are volunteers. The Nevada State Legislature depended on the Center for Fire Research to write a State retrofitting law, as I have mention, that makes our homes, schools, and buildings safer for everyone. As I have mentioned before, of course, this law is a national model.

All across our Nation I can see the effect of this agency on our everyday lives. Fire retardant clothing for children; residential smoke alarms; inexpensive sprinkler systems; and national standards that make our life safer. The work of the Center for Fire Research is dramatic. We can clearly see how it saves lives and prevents tragedy. To impede this agency's assistance to local governments, in my opinion, would be a dereliction of Federal responsibility to protect lives and property. It would be pound wise and penny foolish. There are so many different areas to save money when it isn't something as dramatic as this fire problem that we have sweeping the country.

[The prepared statement of Mr. Walgren follows:]

OPENING STATEMENT
HONORABLE DOUG WALGREN
AUTHORIZATION OF FEDERAL FIRE PREVENTION AND CONTROL ACT OF 1974

MARCH 16, 1983

Good morning ladies and gentlemen. This is an authorization hearing to review the current state of affairs within the Federal fire effort mandated by the Federal Fire Prevention and Control Act of 1974.

Last year we were concerned about the Administration's proposal to eliminate the U.S. Fire Administration. However, a bipartisan effort in Congress appropriated $4.1 million to keep the U.S. Fire Administration (USFA) alive. This year, unfortunately, we are faced with the Administration's proposal to eliminate the Center for Fire Research at the National Bureau of Standards. The Center for Fire Research conducts the only comprehensive fire research program in the country.

This proposal comes at a time when annually 8,000 people die, 200,000 are injured and $5 billion worth of property is lost as a result of fire.

Are we going to continue to let America burn? Are we going to help the American public and firefighters only after the barn has burnt down?

If we eliminate the agency that is improving fundamental understanding of the behavior of fire and its combustion products, what scientific basis do we have to improve fire safety? For example, a decade ago, NBS scientists provided basic information on the characteristics and movement of smoke. This information was incorporated into test procedures used in certifying smoke detectors, which save hundreds of lives annually. The NBS program is aimed at protection of life.

I understand that the USFA is undergoing a reorganization, and it is colocated at the site of the National Fire Academy. I look forward to hearing about priorities for research and action that have been planned at the USFA for the Federal Fire Prevention and Control effort.

The United States has the highest fire death rate among the industrialized countries of the world. That requires national attention, national focus, and national coordination -- based on the best scientific fire data and research available. The public and local firefighters deserve nothing less.

I would like to welcome the distinguished witnesses and look forward to hearing their testimony.

Mr. REID. Mr. MacKay.

Mr. MACKAY. Thank you, Mr. Chairman.

I certainly agree with the comments you have made. One of the areas that has been of great interest to me in Florida over the past 10 to 20 years has been the evolution of the volunteer fire department. This is an area where, with continuing leadership and training, we can have much better fire protection in a number of areas using volunteers, coupled with a centralized research and training program. I personally think this is a very appropriate area for continuing effort at the Federal effort. I am disturbed, as Mr. Reid has said, at the administration proposal to eliminate the Center for Fire Research. I consider this a very important hearing. All of us, particularly those of us who are new members, are frustrated at the scheduling problems—you will have to see us come and go during the course of this meeting. I want to apologize in advance for that and let you know when that occurs, in my case, it certainly is not because of a lack of interest in this hearing.

Thank you, Mr. Chairman.

Mr. REID. Thank you, Mr. MacKay.

Mr. Gregg.

Mr. GREGG. I have no statement.

Mr. REID. Witnesses on the first panel are: Fred Villella, Associate Director of Federal Emergency Management Agency: Dr. John Lyons, Director of National Engineering Laboratory, National Bureau of Standards. Gentlemen.

[The biographical sketch of Mr. Villella follows:]

Federal Emergency Management Agency
Washington, D.C. 20472

BIOGRAPHICAL DATA

THE HONORABLE FRED J. VILLELLA

Fred J. Villella was appointed as Associate Director of FEMA by President Ronald Reagan and was confirmed by the U.S. Senate on June 10, 1981. Mr. Villella holds a dual leadership role with the Federal Emergency Management Agency (FEMA), Washington, D.C., serving as the Associate Director for Training and Fire Programs as well as Director of FEMA's National Emergency Training Center, Emmitsburg, Maryland, which includes the two training elements: Emergency Management Institute and the National Fire Academy. Thus, he is the top Federal executive in the training and education field.

Prior to accepting the FEMA position, Fred served the California Specialized Training Institute, San Luis Obispo, as the Chief of both the academic and administrative divisions. Concurrently, he served as Chief of Staff for the State's Emergency Management Institute.

After completing two tours in Vietnam, Fred retired as a Lieutenant Colonel in the United States Army following 20 years of military service.

Fred Villella earned a BA from Gannon College and his Masters from Indiana University. He has come a long way from his start in academics as a high school English teacher, acquiring a broad, successful management background.

The U. S. Civil Defense Council honored his Civil Defense work in 1982 by naming him the recipient of their coveted Annual Honorary Membership Award.

The Vietnamese Cross of Gallantry, two Bronze Stars, two Legions of Merit, the Army Commendation Medal with four Oakleaf Clusters, five Campaign Stars, and the Meritorius Service Medal are among his many military citations as a professional soldier.

STATEMENT OF FRED VILLELLA, ASSOCIATE DIRECTOR, FEDERAL EMERGENCY MANAGEMENT AGENCY, ACCOMPANIED BY EDWARD WALL, U.S. FIRE ADMINISTRATION AND JOSEPH DONOVAN, SUPERINTENDENT, NATIONAL FIRE ACADEMY

Mr. VILLELLA. Mr. Chairman, I'm Mr. Villella. I have with me from the U.S. Fire Administration, Mr. Edward Wall and the Superintendent of the National Fire Academy, Mr. Joseph L. Donovan.

If I may, I would like to summarize some of my statement, and then proceed with a little description of our fire data system, which I think would be of interest to you.

I first would like to acknowledge your recognition of the enormity of the problem and express appreciation of your comments on behalf of the Federal focus on the national fire problem which is supported by the administration and by the Federal Emergency Management Agency of which I am Associate Director.

Mr. REID. Mr. Villella, your statement will be made a part of the record and you can summarize the same. Thank you, sir.

Mr. VILLELLA. We're pleased to appear before the committee. As you know Public Law 93-498 stimulated efforts on the part of the Federal Government to deal with America's common enemy—fire—and establish the Federal focus on the national fire problem. The Federal Emergency Management Agency will continue to serve as a Federal focus on this effort.

National attention was focused on the Nation's fire problem by the National Commission on Fire Prevention and Control in 1974 with its report, "America Burning."

Mr. Chairman, and members of this committee, America is still burning. Although there has been improvement in a number of communities throughout the Nation in reducing the nature and impact from fire, there continues to be an unacceptable loss of life and property. A single loss of life from fire, the tragedy of destroyed home, serious crippling burns and injuries, or increased economic losses cannot be ignored. The latest statistical information, provided by the U.S. Fire Administration's data program, reveals that in 1981, 7,600 civilians and 123 firefighters lost their lives as a result of fire; 30,480 were injured and there was $6,676,000 in direct property losses.

The fire program in the Federal Emergency Management Agency's focus is an equal partner in this Agency's efforts to raise the entire state of emergency preparedness throughout the Nation, for both natural and manmade disasters. Fire managers are key members of each community's emergency management team.

We are also pleased to report that the U.S. Fire Administration, at this time, is now colocated at the National Emergency Training Center in Emmitsburg, Md., and is functioning in all of the vital program areas. During the past year, this administration and the Congress, with the cooperation of the Nation's fire services, have taken this additional step in providing an improved and cost-effective management of the U.S. Fire Administration functions. The colocation has resulted in increased performance and contributed to the savings of dollars over the previous year's budget.

At this moment the U.S. Fire Administration and the National Fire Academy are collectively addressing the arson problem. There has been an increased application of contemporary technology to fire and rescue services needs in the form of teleconferencing and microcomputers that aid both the training and operational requirements at the community level. Other milestones include advances in the installation of smoke detectors in American homes, experimentation with residential sprinklers, research and better protection for the firefighter through a new turnout ensemble and a lighter, self-contained breathing apparatus, and the publication in the past year of data which reflect a statistical analysis of the Nation's fire problem.

During the past year the Federal Emergency Management Agency, through its civil defense and other disaster related programs, has applied its resources for the advancement of the National Emergency Training Center's efforts within the U.S. Fire Administration and the National Fire Academy activities. This support and direction from the Agency has engendered a greater degree of cooperation within the fire community.

We appear before this committee proud of these accomplishments. However, Mr. Chairman, we cannot, nor do we seek to delude you or the citizens of this country with the suggestion that the national fire problem is solved.

We have dedicated under this act, the Fire Prevention Control Act, our comprehensive and committed efforts to take positive actions that contribute toward a national goal to stop "America Burning." We, therefore, respectfully request the authorization of appropriations for activities under the Fire Prevention and Control Act of 1974.

Your letter of invitation, of February 24, requested that I provide the subcommittee with a brief review of the final budget levels and a listing of grants for the fire programs in 1983. I have submitted those for the record. Briefly, the allocation of dollars is $850,000 in salary and expenses; $1 million in firefighter health and safety; $1,150,000 in data: $750,000 in fire prevention and arson control; and $400,000 in fire service/rescue management improvement. I have submitted all of those, Mr. Chairman, for the record.

Mr. Reid. Thank you.

Mr. Villella. If I can take just a couple more minutes and draw your attention to the charts. Over to your left, the first chart demonstrates what we are receiving from the data system that has been under operation in the U.S. Fire Administration. The black reflects those communities which have a death rate per million population of over 46; the white is under 26.

The next chart, the same system—the national fire incident reporting system—through March 1983, indicates the number of States that are participating in this national data system. The dark colors represent those 40 States and 22 major cities which are now participating voluntarily within the system. The hash marked areas represent those communities in development and the white are those which have not yet come online for one reason or another.

The next chart is a reflection of the data that is derived from this system. In this case it is "direct property losses from fires in residences." Those include: dwellings, apartments, mobile homes, et cetera. The details of that information I have submitted to each of the members of the committee and for the record.

Finally, the next chart indicates on a selective basis, some of which are represented here in this committee, the major cause of 1981 residential fires in those 10 States. The apparent first cause is from heating, the second is from cooking, the third is incendiary/suspicious fires, and the fourth is smoking and electrical distribution and others.

I show these to you, Mr. Chairman, as a reflection of the kind of data that is being acquired through the national fire incident reporting system.

That, essentially, represents a very condensed version of my statement before the committee. If you have any questions we would be delighted to answer those questions.

[The prepared statement by Mr. Villella follows:]

STATEMENT OF THE HONORABLE FRED J. VILLELLA, ASSOCIATE DIRECTOR
FEDERAL EMERGENCY MANAGEMENT AGENCY
ON PL 93-498 FEDERAL FIRE PREVENTION AND CONTROL ACT
BEFORE THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
MARCH 16, 1983

Mr. Chairman, we are pleased to appear before this Committee on behalf of the Administration to seek authorization for appropriation of monies for activities under the Federal Fire Prevention and Control Act, and for other purposes; and to discuss the Federal Emergency Management Agency's plans for carrying out the responsibilities under the Act.

Public Law 93-498 stimulated an effort on the part of the Federal government to deal with America's common enemy - fire - and established a Federal focus on the national fire problem. The Federal Emergency Management Agency will continue to serve as the Federal focus on this effort.

Proposed legislation to authorize appropriations for the fire prevention and control activities has been forwarded to the Speaker of the House of Representatives and the Vice President of the United States. The amount requested is $14,720,000 which is the amount contained in the President's budget. This proposal also requests authorization for such sums as may be necessary for FY 1985. Enactment of this legislation is in accord with the program of the President.

National attention was focused on the Nation's fire problem by the National Commission on Fire Prevention and Control in 1974 with its report, "AMERICA BURNING". This report, although recognizing that fire is a local problem, provided justification for a Federal program to supplement the efforts of fire prevention and control activities administered capably at the state and local levels. Although, the magnitude of the Nations fire problem varies from state to state, over the years state and local governments have provided productive and dedicated service to the public. Our effort is to support and encourage these efforts.

Mr. Chairman, and members of this committee - America is STILL burning! Although there has been an improvement in a number of communities throughout the Nation in reducing the nature and impact from fire, there continues to be unacceptable losses of life and property. A single loss of life from fire, the tragedy of a destroyed home, serious crippling burns and injuries, or increased economic losses cannot be ignored. The latest statistical information, provided by the U.S. Fire Administration's data program, reveals that:

> In 1981 7600 civilians and 123 fire fighters lost their lives as a result of fire. 30,480 were injured and there was $6,676,000,000 in direct property damage.

The Federal Emergency Management Agency administers two critical components of the Federal Fire Prevention and Control Act - The National Fire Academy and the United States Fire Administration. The Fire service is an equal partner in this Agency's efforts to raise the state of emergency preparedness throughout the Nation, for natural and man-made disasters. Fire managers are key members of each community's emergency management team. In order to advance the professional development of fire service and others engaged in fire prevention and control activities, the National Fire Academy program provide technical, management and public education training. The National Fire Academy has grown, in fulfilling the mission given to it by Congress. There has been an increase of several thousand student graduates since 1980 when the National Fire Academy first took up residence at its present facility at the National Emergency Training Center in Emmitsburg, Maryland.

In a program which began in the fall of 1982, 4,200 students have already been trained by local trainers using Academy-developed hand-off packages at minimum cost to the Federal government. It is significant to note that the increase in students, and the enhancement through training of the Nation's fire and rescue and allied service have occurred without a proportional increase in funding.

This is a very proud accomplishment in providing growth in the service to the citizens of our country, through the Nation's fire and allied services.

We are also pleased to report that the United States Fire Administration is now collocated at the National Emergency Training Center, and is functioning in all of the vital program areas. During this past year, this Administration and the Congress, with the cooperation of the Nation's fire services, have taken this additional step in providing an improved and cost effective management of the United States Fire Administration functions. The collocation has resulted in increase performance and contributed to the savings of dollars over the previous year's budget.

The collocation has also improved the dialogue and substantially assisted in the coordination of the Federal Emergency Management Agency's fire safety and emergency management activities.

The programs of the United States Fire Administration are designed to assist and supplement the activities of the states and communities and are designed to provide leadership, and focus on those critical areas which have the greatest potential for reducing this Nation's unacceptable fire losses. The programs address:

a. Fire data and analysis

b. Fire prevention and arson control

c. Fire fighter health and safety

d. Fire and rescue management and policy coordination

Each of these areas contains direct and indirect programs responsive to the needs of the Nation. Each area is reflective of contemporary requirements to improve technologies to deal with the complex aspects of the fire problem in America. The United States Fire Administration continues to take the lead in coordinating the participation of other Federal and private sector agencies.

The United States Fire Administration has, in conjuction with the National Fire Academy, contributed towards a progressive and pro-active treatment in Public Fire Safety Education.

This enhanced direction was highlighted in a national Conference held this year in what has been recognized as one of the most productive action-oriented public education conferences in the history of Federal fire programs. At this moment, the United States Fire Administration and the National Fire Academy are collectively addressing the arson problem. There has been increase application of contemporary technology to fire and rescue service needs in the form of teleconferencing and microcomputers that aid both the training and the operational requirements at the community level. Other milestones include advancing the installation of smoke detectors in American homes, experimentation with residential sprinklers, research in better protection for the fire fighter through a new turnout ensemble and a lighter, self-contained breathing apparatus, and the publication in the past year of data which reflect a statistical analysis of the Nation's fire probelm.

During this past year, the Federal Emergency Management Agency, through its civil defense and other disaster related programs, has applied its resources for the advancement of the National Emergency Training Center's efforts within the United States Fire Administration and the National Fire Academy activities. This support and direction from the Agency has engendered a greater degree of cooperation within the fire community.

We appear before this committee proud of these accomplishments. However, Mr. Chairman, we cannot, nor do we seek to, delude you or the citizens of this country with the suggestion that the national fire problem is solved.

We have dedicated, under this Act, our comprehensive and committed efforts to take positive actions that contribute towards a national goal to stop "America's Burning". We, therefore, respectfully request the authorization of appropriations for activities under the Federal Fire Prevention and Control Act of 1974.

Mr. **Reid**. The questions we will save until this panel is completed.

Dr. Lyons.

[The biographical sketch of Dr. Lyons follows:]

JOHN W. LYONS

Date of Birth: November 5, 1930

Birthplace: Reading, Massachusetts

Education: Degrees

Harvard University, A.B., Chemistry
1952
Washington University, A.M., Physical Chemistry
1963
Washington University, Ph.D., Physical Chemistry
1964

Position:

Director
National Engineering Laboratory
National Bureau of Standards

As Director of the National Engineering Laboratory and past Director of the Institute for Applied Technology Dr. Lyons is responsible for research in applied mathematics, building technology, consumer product technology, electronics and electrical engineering, energy conservation, engineering standards development, fire, mechanical engineering and process technology, and technological innovation and the application of results from this research in solving significant National problems.

Dr. Lyons was Director of the Center for Fire Research until December 18, 1977, and was responsible for providing scientific and technical knowledge applicable to the prevention and control of fires, including basic and applied research for the purpose of arriving at an understanding of the fundamental processes underlying fires, and the effects of fire on people.

From 1969 until his appointment as Director of the Center for Fire Research on October 1, 1973, Dr. Lyons was Manager of Commercial Development for Monsanto Industrial Chemicals Company and head of the firm's Fire Safety Center. Prior to 1969 he held various positions in research management at Monsanto Company. After two years in the US Army he joined Monsanto Company as a research chemist in 1955 and he remained with the company until joining NBS in 1973. A physical chemist, Dr. Lyons previously served the Bureau from 1971 to 1973 as a member of the ad hoc panel on fire research, a National Academy of Sciences visiting committee.

Dr. Lyons won National recognition with two books: Viscosity and Flow Measurement and The Chemistry and Uses of Fire Retardants, both standards in their field. He has contributed chapters to five other books and written numerous papers and articles for technical journals. He is a Fellow of the American Association for the Advancement of Science, Fellow of the Washington Academy of Science, a member of the American Chemical Society (and past chairman of the St. Louis Section), Sigmi Xi, and he has served as a visiting lecturer at various universities. Dr. Lyons serves on the U. of Maryland's Engineering College Advisory Committee, is a member of the Board of Directors of the National Fire Protection Association, and assists the Admission Office of Harvard in evaluating high school students applications. The Gold Medal was awarded to Dr. Lyons in the fall of 1977 for his exceptional management skills in developing the Center for Fire Research. He received the 1978 Presidential Management Improvement Award. He also served (1974-1979) as Chairman, Products Research Committee, a nine-member charitable trust which administered a $5 million fire research fund established under terms of a consent order entered into by the plastics industry and the Federal Trade Commission.

STATEMENT OF DR. JOHN LYONS, DIRECTOR, NATIONAL ENGINEERING LABORATORY, NATIONAL BUREAU OF STANDARDS

Dr. LYONS. I call your attention to the monitor at your left. On February 14, Valentine's Day, at the Bureau we were visited by a delegation from this subcommittee who braved the snow. Congressman Walgren and Congressman Reid, appeared with a number of staff and we showed them a number of things. Among those were this standard room fire test and the subcommittee requested that we show this film at this time.

We were demonstrating the nature of large-scale fire tests and the intensity of fire that can develop in a room containing materials. We want to show you the interactive nature of fire; that is, a fire is so intense because of the interactions. Here is the chairman igniting the fire. It takes about 10 seconds to ignite the materials. This is an 8 by 8 by 8 room, furnished with plywood walls, fiberboard ceiling, polyester carpet. The sofa is an item of furniture that you can buy in any store, it's a polyolefin fabric over a synthetic, plastic foam padding. We ignite by an electrical source touching off a book of matches which is behind the newspaper. Some of you may be able to see the clock at the bottom. The fire will develop almost entirely in the padding on the sofa. We are interested in the rate of development of the fire. A test such as we are running now might be used by a routine testing laboratory that was seeking only information on time to what we call flashover, which is that point when all items in the room are burning. If you want to know more details about the fire one would have to add a good deal of instrumentation and, in fact, for most NBS tests the test site is pretty well filled with test apparatus. As the camera withdraws and shows you the door way you will see on the floor a couple of pieces of crumpled newspaper. These aren't very sophisticated sensors, but the end point when all materials are burning is very reproducible and we gage that by the point at which those pieces of newspaper on the floor burst into flame. That will happen not because they are contacted by the flames, but because of radiation from the hot gases in the ceiling.

The fire now is acting as a pump, the cool air is coming in at the bottom and the fire gases are coming out at the top. We are now at 1 minute 38 seconds. Flashover will occur at 1 minute 53 seconds, I think it is. You see the neutral zone coming down. You can see some of the fabric melting and dripping on the floor. You see steam coming out of the newspapers—they are about to ignite. That's flashover. Rather shortly after flashover there will be no further entry into the room of combustion air, and all the burning will be occurring outside the door, so it appears as one great big jet. Here, the chairman moved over to take a look directly into the fire rather than on the monitor. Another interesting thing about this film—here we have virtually no air going in—is the effect of sprinklers. We routinely put these fires out with one standard sprinkler head manually activated on signal from the project leader. A couple of gallons of water is enough to put the fire out. There it goes. That of course creates a good deal of steam which cools the combustion gases and quenches the fire.

So now we know something about room fire tests.

Mr. Chairman, Raymond Kammer, Director of NBS, at my right, and I are pleased to be here this morning to testify on the Center for Fire Research program.

I will give a brief summary of my statement and I request that the full statement be included in the record.

Mr. REID. That will be the order.

Dr. LYONS. The Center for Fire Research at the National Bureau of Standards currently has onboard 111 people, 79 of whom are full-time permanent employees; received in fiscal 1983 direct appropriations of $5.8 million and expect to have sponsored funds from other Federal agencies of between $2 and $3 million.

Of the direct appropriations, some $2 million is used for grants, largely to academic institutions. This $2 million constitutes the bulk of the funding of academic fire research in the United States.

The 1984 budget for the Bureau of Standards proposes no funds for this center and proposes closing it down.

In the letter of invitation from Chairman Walgren was a request for a short history of the Center for Fire Research and its achievements. These are in the appendix of my testimony which has just been put in the record. That summary begins with the efforts of the Bureau of Standards and the National Fire Protection Association to standardize fire hose couplings, a problem which dramatically came to light in the great Baltimore fire of 1904. That standardization was accomplished a year or two afterwards by joint effort of the fire community.

A few achievements of the last decade, during which time the Center itself has been established and operating; first, I would cite our role in understanding the performance of smoke detectors; developing standard test methods for smoke detectors, which are now used by certification laboratories; and understanding the behavior of fire, such that we could make recommendations as to the optimum sites for installation of one or more smoke detectors in the home. I am sure the committee knows the great commercial success as well as safety success of the residential smoke detector.

We developed over the past decade a major thrust in the modeling of fire processes, and by that I mean mathematical or analytical modeling. We showed our visitors at the Center some of the results of that on the computer graphics terminal in the fire test building.

We have made great progress in modeling fires, and I am confident that one day most fire decisions and fire engineering will be done on computers.

We developed a series of methods for assessing tradeoffs in reaching a specified level of fire safety; that is, cost-benefits tradeoffs and providing designers options to reach a given level of safety. The results of this so-called fire safety fire evaluation system have lead to great savings already in the hospital and nursing home area, and we look for similar results to accrue in board and care facilities, in multifamily housing, and, most recently, in jail and prison construction.

In the past year, we mentioned in the testimony several accomplishments. Perhaps the most noteable of these, in terms of publicity at least, was the report that we issued in June 1982 on our test method for assessing the toxicity of combustion products. We are continuing further development on that test method at this time.

Congress, in December 1982 in the continuing resolution, added an extra $350,000 for our program on toxicity research; specifically for sponsored work in outside laboratories. The plans for that are progressing well and, in fact, I recently signed a procurement request for the bulk of those funds.

We have improved our fire testing work using the oxygen consumption concept, which is a very simple relationship between the oxygen consumed per pound of fuel and the heat released. It turns out it is much easier to measure oxygen depletion in the fire gas stream than it is to measure directly the heat released from a particular fuel.

We have now adopted this concept for laboratory scale testing apparatus and for full-scale procedures, both for evaluating single items being burned and for large-scale room testing.

We have delivered to sponsors new technical information on wood burning stoves. These include guidelines for installation of such stoves, and also guidelines for safe operation.

Finally, as I mentioned earlier, the fire safety evaluation system continues to move forward. The system for hospitals and nursing homes is already in the NFPA life safety code. We expect that the board and care fire safety evaluation system will also shortly be adopted by the NFPA's life safety code.

That's a very brief summary of our program, Mr. Chairman. Mr. Kammer and I will try to answer any questions that you have.

[The prepared statement of Dr. Lyons follows:]

U.S. DEPARTMENT OF COMMERCE
STATEMENT OF
JOHN W. LYONS, DIRECTOR
NATIONAL ENGINEERING LABORATORY
NATIONAL BUREAU OF STANDARDS
BEFORE THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
ON THE FEDERAL FIRE PREVENTION AND CONTROL ACT
March 16, 1983

Mr. Chairman and Members of the Subcommittee:
Raymond Kammer, the Deputy Director of NBS, and I are here to discuss the fire research programs of the National Bureau of Standards' Center for Fire Research.

The Center has a staff of 111 people, 79 of which are full-time permanent employees, and an FY 1983 budget totaling about $5.8 million in direct appropriations. Another $2.4 million is expected in reimbursements from other Federal agencies. Of the direct appropriations, $2 million is being used for research grants. This $2 million represents the bulk of funding for fire research at American universities. About $1 million of the $2 million in grant funding replaces a National Science Foundation funded fire grant program transferred to NBS about six years ago.

The NBS budget for FY1984 proposes elimination of the Center and its fire research program. The fire research program contributes technical information for building codes, an area that is primarily the responsibility of State and local governments. Significant benefits accrue to the construction community through reduced construction costs. The construction community, in cooperation with State and local building code officials, can carry out research in this field by supporting work at qualified private laboratories and at universities. Assuming Congressional approval of this proposal, the Center for Fire Research will be closed down.

In your letter of invitation, Mr. Chairman, you requested a brief history of the Center for Fire Research and a review of its achievements. That material is attached as an appendix to my testimony. However, I would like to review briefly a few of our accomplishments in fire research over the past year.

We have continued our studies of the toxic effects of combustion products. In June 1982 we published a report which presented and discussed our laboratory testing procedure. Subsequently we held workshops to explain the test method and its limitations to industry and government officials. Congress specified in the December 1982 continuing resolution that $350,000 in additional funds be spent in this area. We are currently completing planning for this work and expect to reach agreement this month on work statements for grants to research institutions in the private sector.

We have advanced the use of the oxygen depletion concept in fire testing. This concept makes use of the nearly constant relation between the amount of oxygen consumed per unit weight of fuel and the heat released. Experimentally, oxygen depletion in off-gases is easier to measure than the heat itself. We have finished work on a laboratory-scale test apparatus. We have continued to conduct full-scale tests of single items of frame furniture using this measurement concept. We have sponsored evaluations of a complete room fire test method using oxygen consumption as a key parameter. We anticipate that the voluntary standards community will adopt these procedures.

The NBS Fire Safety Evaluation System is a method for justifying the use of various alternatives in construction to meet a given level of fire safety. First developed for hospitals and nursing homes, the method has now been adopted to the needs of board and care homes. Other variants are being developed. I refer you to the appendix for the details.

Finally, we have developed new technical information on the fire safety aspects of using wood burning stoves. We studied the thermal environment around such appliances and issued new technical guidelines for installation in terms of separation from combustibles. We also studied the tendency of wood stoves to generate combustible tars in chimneys and elucidated the factors which affect this tendency.

This concludes my prepared testimony. Mr. Kammer and I would be pleased to answer any questions that you or other members of the Subcommittee may wish to ask. Thank you.

Appendix to
Statement of
John W. Lyons, Director
National Engineering Laboratory
National Bureau of Standards
before the
House Committee on Science and Technology
Subcommittee on Science, Research and Technology
on the Federal Fire Prevention and Control Act

March 16, 1983

HISTORICAL NOTES AND SOME ACCOMPLISHMENTS
OF
FIRE RESEARCH
AT THE
NATIONAL BUREAU OF STANDARDS

HISTORICAL NOTES

The Fire Research Center at the National Bureau of Standards was established in 1974 in Section 18 of the Federal Fire Prevention and Control Act (Public Law No. 93-498). Before this, NBS had conducted a smaller fire safety engineering effort within its building research program. NBS's work began with the great Baltimore fire of 1904 in which 155 acres of the downtown area burned and 2500 structures were lost. Fire companies arriving from Washington, Wilmington and Philadelphia found that their hose couplings would not fit the Baltimore hydrants. Afterwards NBS developed a standard for fire hose threads and made available a standard set of dies for use by manufacturers. The National Fire Protection Association then issued a product standard. The Bureau has been active in fire research ever since. The emphasis has changed with changing public needs.

During the first half of this century fire research was engaged in developing the principles and techniques necessary for peventing the loss of entire buildings to fire. At NBS the relationships between the amount of combustibles in a space and the maximum fire intensity were worked out through a series of full-scale test fires. NBS worked closely with Underwriters' Laboratories, the National Fire Protection Association, the

American Society for Testing and Materials, Factory Mutual Research Corporation and many others in developing and gaining acceptance for these ideas. This information provided the basis for the fire endurance concept - one-hour, two-hour, four-hour ratings on columns, beams, and other structural members. Adoption of this technology by the building codes for large, public structures provided buildings which could and do maintain structural integrity even in the severest of fires.

In 1974 when the Congress enacted the Federal Fire Prevention and Control Act research attention was shifting from preventing loss of buildings to reducing deaths and injury in fire wherever they occur. This is not to suggest that property losses had been eliminated by the earlier work, but techniques for controlling property loss in large expensive structures had developed at a good rate. Engineers knew how to install sprinklers activated by heat, they knew how to protect stairways by means of fire-rated enclosures, and how to compartmentalize buildings such that a fire breaking out in one area had little chance of spreading to other, adjacent areas or of endangering people on other floors. The problems in property protection were then, and are now, how to obtain the desired level of safety at the lowest possible cost and how to enforce the building regulations. (It is exceedingly rare that a major fire disaster occurs in a public structure built faithfully according to the applicable building code.)

The assignment to the Fire Research Center at NBS was comprehensive: "basic and applied fire research for the purpose of arriving at an understanding of the fundamental processes underlying all aspects of fire...." Public Law 93-498, Section 18.

The data on fire losses were adequate to show the sequences or scenarios that accounted for most fire deaths. It was immediately clear that most deaths were occuring in residences by ones and twos and not in public buildings. This explained why the effort on large structures had succeeded in saving those buildings but had not markedly affected the death rate from fire. Strange as it may seem, the spectacular multi-fatality fires that occasionally catch the Nation's attention do not represent the bulk of the problem of fire deaths and injuries. NBS staff arrayed the fatal fire scenarios in order of importance and then listed intervention strategies for each. We estimated the impact of each strategy, if successful, and drew up a plan of research appropriate to NBS accordingly. That plan was subsequently published in the record of proceedings of this Subcommittee. (Committee Pnint No. 57, January 22, 1975, FIRE, Hearing before the Subcommittee on Science, Research and Technology of the Committee on Science and Technology, U.S. House of Representatives, Ninety-fourth Congress, Second Session, pp. 64-133.) NBS has been working its way through this agenda ever since.

SELECTED ACHIEVEMENTS SINCE 1974

Combustion Research

- Fundamental studies of the mechanism of soot formation in fires are continuing. Soot is a major factor in creating hazardous fire conditions. It obscures vision, interfering with escape, rescue, and fire fighting; it provides a mechanism for tranporting hazardous combustion products; the radiation properties of soot have a major influence in controlling the spread of fire; and smoke particles provide the most reliable mechanism for early detection of fires.

- The mechanism of smoldering combustion has been elucidated. This poorly understood process has been a major cause of deaths in residential fires. Better understanding of the mechanism will contribute to the development of smolder-resistant materials, the control of smoldering ignition, and better understanding of the toxic properties of the products of smoldering combustions.

- Studies of the radiant ignition of a variety of fuels have led to a better understanding of the mechanism of ignition of fire fuels and contributed to improved test methods and ignition control.

o Optical properties of smoke influence smoke detector performance. A laser has been used to make the first, direct measurement of the refractive index of individual smoke particles produced by smoldering cellulose. We are now gathering further data to examine variation in refractive index among particles of different size produced by the same source and particles from different sources.

Modeling of Fires

Mathematical modeling of fire development promises to become a powerful tool for increasing the fire safety of all types of structures. Computer models allow the examination of a wide range of fire environments without a great deal of costly large scale testing. Rapid progress has been made in recent years and practial applications are now possible. The ultimate goal is to place fire protection engineering on a sound technical base, comparable to other engineering disciplines. We fully expect that most large scale testing and most code decisions will be made via computer simulations by the end of the century. Here are some notes on contributions from NBS staff and by a number of our grantees.

o Detailed mathematical predictions have been made of the large scale fluid motion and smoke transport generated by a fire in an enclosure. A two-dimensional model predicting fluid motion and smoke coagulation has been combined with a smoke detector model to simulate detector response. Preliminary results have been achieved with a three-dimensional version of the particle tracking algorithm. This work will have application to the study of smoke detector siting and flame spread on walls and ceilings.

o An improved method has been developed for predicting details of the outflow of hot gases and the inflow of ventilation air through door and window openings of a room containing a burning object. These details of the flow may affect significantly the growth rate of the fire and the supply of combustion products to the rest of a building. The technique has been validated by full scale experiments. The work is being extended to include wall fires.

o In the event of fire in a building compartment, the time available for the occupants to evacuate the compartment safely depends on the time of fire detection and on the time of the onset of hazardous conditions. To calculate this available safe egress time, a computer program and user's guide have been developed.

o A computer program was developed to predict the movement of smoke through a building. This will make possible the investigation of building design features and smoke control systems without the necessity for expensive full scale tests.

Test Method Development

o Subsequent to passage of the 1967 amendments to the Flammable Fabrics Act, the Center for Fire Research developed test methods for carpets and rugs, childrens sleepwear and mattresses. Today all such products sold in the United States must meet standards based on these tests. Deaths and injuries from fires involving these products are reduced. For example burn centers report very few injuries in which sleepwear is the item ignited.

o NBS conducted a lengthy sequence of studies on the cigarette ignition of smoldering combustion in upholstered furniture. A method of test from NBS has been modified and adopted by the furniture manufacturers and is the basis for the voluntary labeling program now in place.

o Laboratory methods developed by NBS for testing smoke detectors are now in use by laboratories which certify such detectors.

o Research done at NBS helped show the optimum locations for installing smoke detectors in the home.

o A laboratory scale apparatus for the measurement of rate of heat release using the CFR-developed oxygen consumption principle has been submitted to ASTM for adoption as a standard test method. (This principle makes use of the nearly constant relation between oxygen consumed and heat released for most fuels.)

o This simple oxygen consumption principle is finding wide application in fire research. In CFR it has been scaled up to measure the rate of burning of full size furniture pieces and it has been incorporated in the full scale room fire test, developed jointly by CFR and a grantee at the University of California, which is now being considered by ASTM.

o A test method for the evaluation of the acute inhalation toxicity of combustion products has been developed, published, and submitted to ASTM. The method is suitable for research and material development purposes but the results must be combined with additional factors to evaluate the toxic threat posed by a product in a specific application.

o An interlaboratory evaluation of the test method, involving industrial, academic, and government laboratories, has been completed.

o A workshop was conducted to inform building code officials of the scope and application of the test method. A similar workshop will be held in California and perhaps in other locations. Members of the CFR staff participated in studies of the combustion product toxicity problem conducted by the National Fire Protection Association, the American Society for Testing and Materials, and the National Institute of Building Sciences.

o In cooperation with the National Fire Protection Association and the Federal Emergency Management Administration, we participated in recent years in studies of a number of major fires where smoke and gas produced numerous casualties. These included the Beverly Hills Supper Club, the MGM Grand Hotel fire, the Westchase Hilton fire, and the Biloxi Jail fire.

Smoke Control

o Work on a Building Smoke Control Systems Design Manual is nearing completion. This has been a joint project between the Center for Fire Research and the American Society for Heating, Refrigerating and Air Conditioning Engineers. The Manual explains for the first time how to design and analyze pressurized stairwell systems and zone smoke control systems and includes a computer program for use with complex building designs. Publication is scheduled for 1983.

o The smoke leakage characteristics of fire doors affect the time available for safe refuge or egress from a burning building. A method for measuring the leakage of door assemblies during standard fire exposures has been developed and published.

o A series of full scale tests to evaluate smoke movement through a suspended ceiling into an interstitial space of a hospital-type facility was conducted for the Veteran's Administration. It was concluded that the use of the interstitial space for exhaust can effectively prevent hazardous conditions due to smoke downflow through suspended ceilings.

o Smoke movement tests were performed on two merchant vessels and a report discussing the application of smoke control techniques to merchant ships has been published. Ventilation requirements for container ship holds were determined for the Coast Guard and the resulting recommendations have been adopted by the International Maritime Organization.

o A joint program to study smoke movement and control in stair towers was conducted with the Centre Scientifique et Technique du Batiment (CSTB) in France. These experiments made use of the French fire tower facility, thus avoiding the need to duplicate this costly facility in the United States.

Residential Sprinklers

o Demonstration tests of residential sprinklers were carried out in cooperation with FEMA. Changes were introduced into the National Fire Protection Association (NFPA) sprinkler standard to make application of light duty sprinklers to residential occupancies economically feasible.

- Methods of estimating the response time of fast-acting sprinkler heads necessary for residential life safety were developed. Such heads are now commercially available. The growth rate of most fires increases as the fire progresses, which makes the activation time of a sprinkler system critical to life safety. Full-scale experiments were carried out on the effect of the location of pendent and sidewall sprinkler heads on their response characteristics in small enclosures. This information will be of use in efficient sprinkler system design.
- The fundamentals of sprinkler performance are being studied to increase the effectiveness and reduce the cost of residential sprinkler systems.

Heating Appliance Fires

- An analysis was completed on over 1600 fire fatalities to identify the causes leading to demonstrated high fatality rates in rural areas. It was found that the most significant rural fire fatality causes were heating equipment with improper installation and misuse of solid-fueled heating equipment.

- The operation of solid-fuel heating appliances, e.g., wood stoves and fire places, etc., was studied and improved methods for the safe design, installation, operation and maintenance of such devices were introduced into the fire safety standards.

Fire Safety Evaluation Systems

NBS developed the concept of a fire safety evaluation system to provide a means of meeting the equivalency provisions of the building codes. Most codes prescribe a means of meeting the level of safety specified and admit the possibility of using equivalent but different means. There has been no formal way to demonstrate this equivalency. The NBS-developed system applies a quantitative rating of the level of safety specified and of various component parts of a strategy to meet this level. Thus one receives so many points for having detectors, so many for sprinklers, so many for fire-rated doors, and so on. The idea is to allow owners and designers options while maintaining the desired level of safety. (Most of the work has been done by panels of experts; eventually the systems should be converted to a basis of calculations using physical models.) This approach has been rapidly picked up by users as evidenced by the following notes.

o The Fire Safety Evaulation System for Health Care Facilities is now included in Federal regulations and the National Fire Protection Association's Life Safety Code. A computerized cost optimization model for the application of this system for health care facilities has been completed. Application of the system to the retrofit of representative existing hospitals to meet new fire safety requirements has resulted in savings of millions of dollars. The potential savings run into the billions. This will help to hold down the rate of increase in the cost of medical care.

o A Fire Safety Evaluation System for Multi-family Housing has been developed for the Department of Housing and Urban Development to identify alternative combinations of widely accepted fire protection systems and building design features that provide a level of safety equivalent to that required by HUD Minimum Property Standards.

o The Fire Safety Evaluation System for Board and Care Facilities has been completed and accepted by the National Fire Protection Association's Subcommittee on Residential Occupancies for inclusion in the next edition of the Life Safety Code. Implementation of the system will provide increased fire safety for the elderly and the handicapped at affordable costs.

o The Fire Safety Evaluation System for Detention and Correctional Occupancies has been completed and accepted by the Subcommittee on Detention and Correction Occupancies for inclusion in the next edition of the Life Safety Code.

Arson Control

o An approach based on decision analysis has been formulated and demonstrated to provide a planning tool for decision makers in a city or community concerned with selection and application of arson strategies. The Arson Information Management System (AIMS) provides information to describe the arson problem (classify causes/motivation, incidence and magnitude for each area in the city/community) and to establish which strategies are appropriate to address the causes. A method for using the outputs from the decision analysis to provide the most cost-effective use of an arson budget has been developed.

o Various commercial devices (sniffers) for the detection of accelerants were evaluated and a performance specification was developed to assist authorities in procuring suitable equipment.

o An interlaboratory study of test methods used by various forensic laboratories to identify accelerants in fire debris was initiated. Early results indicated shortcomings in the methods. Efforts are under way to develop improved procedures which are expected to lead to the development of a standard test method.

Mr. Reid. Thank you.

Mr. Villella, what impact will the elimination of the Center for Fire Research at the National Bureau of Standards have on Federal fire prevention and control efforts?

Mr. Villella. Mr. Chairman, we acknowledge the valuable work done by the Center for Fire Research in the areas for which they are responsible. There is a distinction between the kind of research performed by the Center for Fire Research and that accomplished through the U.S. Fire Administration. I am not sure that I could detail the impact on fire prevention and I suppose a justification for that kind of response is the fact that we already know so much of what we should be doing that I'm not sure what the immediate impact would be

Mr. Reid. You do acknowledge, however, that it would have significant impact on fire prevention generally, wouldn't it?

Mr. Villella. The work that has been accomplished is very valuable work, and obviously the loss of the work accomplished by the Center for Fire Research would have a distinct impact. Yes, sir.

Mr. Reid. What projects at the Fire Administration have not been completed? Are there plans underway now to complete those programs that haven't been completed?

Mr. Villella. Are the projects U.S. Fire Administration?

Mr. Reid. Yes.

Mr. Villella. Mr. Chairman, I would be pleased to submit that for the record because we have so many programs that are valuable programs that have an impact across the Nation that are under operation right now—they are ongoing and probably need to continue to be ongoing——

Mr. Reid. You'll submit that for the record? The point being: there are programs that are underway and if these funds are eliminated they won't be completed?

Mr. Villella. That's correct.

[The material follows:]

Federal Emergency Management Agency

National Emergency Training Center
Emmitsburg, Maryland 21727

Insert for the Record

In order to be fully responsive to the Chairman's question, there needs to be a clear understanding that the U.S. Fire Administration and the Center for Fire Research are in separate parts of the federal government, each with their separate budgets and programmatic responsibilities. The current program plans for the U.S. Fire Administration include the following projects that would be eliminated if the Federal Fire Prevention and Control Act were not re-authorized and appropriate funding made available for their continuation.

Improvement of NFIRS

The aim of this project is to determine, from the users' perspective, how to improve the National Fire Incident Reporting System (NFIRS) and how to make data collected through the system more accessible and useable at the local level.

Review of Fire Administration Historical Accomplishments

A review will be made of Fire Administration accomplishments in terms of carrying out mandates of the National Fire Prevention and Control Act of 1974 as amended. Purpose of this review is to ensure programs undertaken by the Fire Administration in the future follow through in meeting mandates of the Public Law without duplicating work already done. In addition, this review will serve as the basis for recommendations for updating language in the Public Law.

Public/Private Sector Partnerships

The Fire Administration will examine and document existing public sector/private industry partnerships to address fire prevention-related problems which can serve as models for similar activities in the future.

Regional Fire Libraries

The Fire Administration will update, and expand where feasible, fire-related information materials available through FEMA's regional offices.

Long-Range Plan

A new 5-year plan for the Fire Administration will be developed.

FIREFIGHTER HEALTH AND SAFETY

Priorities for fire fighter health and safety include assisting in the development of improved protective clothing and equipment, establishing preventive programs, and improving diagnostic and immediate care procedures for fire victims.

Ongoing programs for FY 1983 are:

Apprenticeship Training

Managed by the International Association of Fire Fighters, in cooperation with the International Association of Fire Chiefs, this program is a continuation of support for development and tracking of basic fire training and related work in cooperation with municipal governments.

Project FIRES (Firefighter Integrated Response Equipment System)

Through grants to the International Association of Fire Chiefs, the International Association of Fire Chiefs, the International Association of Fire Fighters and to 14 cities across the United States, this project is a continuation of research, development and testing of an improved turn-out suit for structural fire fighting. During FY 1983, a model suit is being field tested by firefighters on the job. Design deficiencies identified by users in these tests will be corrected and incorporated into the prototype for a second series of field tests. Data from the final field tests will be analyzed and published.

Low Profile Breathing Apparatus

The Fire Administration will continue to work with the U.S. Bureau of Mines and U.S. Divers Corporation in the research and development of a long-duration (2 hour), positive-pressure, mixed-gas system. Efforts are being directed at improving design and making the units more accessible to the fire service by reducing costs. It is projected that certification of the prototype by the National Institute for Occupational Safety and Health (NIOSH) can be accomplished during FY '83.

New Initiatives for FY 1983 include:

Fire Injury Diagnostic Procedures

This project will begin with a voluntary data collection effort from emergency room medical personnel on the current diagnostic protocols relating to fire injuries. From this data, the Fire Administration hopes to develop for emergency medical personnel standard protocols for the proper diagnosis of fire-related injuries.

Fire Fighting Tools and Equipment Research and Development

This initiative is aimed at identifying innovative tools and equipment applicable to fire fighting, modifying or improving on designs where appropriate and transferring that technology to departments across the country.

Fire Service Safety Officer Guide and Manual

As a resource to fire departments creating the position of Fire Safety Officer, the Fire Administration will codify work by a variety of organizations covering applicable standards, references sources and suggested practices.

Arson Information Management Systems (AIMS)

AIMS is an ongoing information system providing for the exchange of economic, social, and criminal justice information among law enforcement agencies, investors, bankers, and state and local anti-arson groups. During this fiscal year, USFA plans to determine whether state-of-the-art data management and information processing technology are being used by AIMS. An evaluation component will be integrated into the system to analyze the system's effectiveness. A specific city will be selected for study and development of a model program.

Juvenile Firesetter Treatment Program

A number of fire departments have been conducting research to determine the effectiveness of training firefighters as volunteer counselors to reduce juvenile arson and firesetting. To date, data have been gathered on age groups up to 7 and from 7-15. Focus for FY-83 is on the 15-18 group. (50% of all arson arrests are of juveniles 18 and under.)

An evaluation system will document and validate the program's effectiveness in reducing juvenile firesetting incidents.

Federal Arson Task Force

The Federal Arson Task Force consists of representatives from various federal agencies with responsibilities or interests relating to arson. Chaired by FEMA, the Task Force serves as a forum for these agencies to exchange information on current and proposed programs.

In addition to regular bi-monthly meetings of the Task Force, the Fire Administration will host during the year short resident seminars at the National Emergency Training Center (NETC). Outside guest speakers and experts in the field will be invited to contribute to this exchange, providing a wider range of information and greater visibility to the effort.

Codes

Much work still remains to be done in the area of code unification and standardization. The Fire Administration will work with organizations that develop fire standards and encourage more private sector involvement in code development and implementation. The aim of this project is to build on previous work related to code administration and enforcement done by the Fire Administration and to provide local officials with the knowledge and skills necessary to develop a strong, pro-active code process at the local level.

Residential Sprinkler Program

This is a multi-year phased project which builds on technical work already accomplished in cooperation with fire-related organizations and the private sector under Fire Administration Sponsorship. Initiatives in this area will be aimed at encouraging an awareness on the part of the public and business and industry of the benefits of and technical improvements available in residential sprinklers and by promoting their adoption and use.

Smoke Detector Survey

Information will be gathered to provide current statistics on smoke detectors in the U.S. including how many are in use, average costs, maintenance costs and problems, and their effectiveness and efficiency. In addition, an assessment of the effectiveness of existing local/state legislation mandating use of smoke detectors will be made.

Teleconferencing

During 1983, the Fire Administration will explore opportunities for using teleconferencing as a means for transmitting and exchanging information on arson.

Arson Resource Center

Through the Learning Resource Center at NETC, arson information will be compiled and disseminated on request. Data gathered by the Fire Administration to date will be supplemented by current information from other sources to provide a centralized national resource on the arson problem.

Arson Computer Project

This project will introduce and encourage the application of microcomputers to the arson problem. Potential program directions include encouraging attendance at the Academy's new microcomputer course and tracking innovatinve programs started at the local level as a result of this training. In addition, information will be gathered to evaluate the effectiveness of computers as a resource for addressing the arson problem.

Rural Arson Project

This 3-phase study will identify the rural arson problem in the U.S.; suggest strategies to mitigate the problem; and measure the success of those strategies.

NFIRS Grants

To ensure the collection of accurate fire data throughout the United States, second - and third-year NFIRS grants to states/localities already committed to participation will continue. Overall, the NFIRS program will focus on upgrading the quality of current data and making it more readily available at the local level.

Technical Improvement and Support

Working with FEMA's Office of Information Resources Management, the Fire Administration is continuing to collect, process and feed back to users data on the U.S. fire problem. Initiatives in this area will be aimed at developing more useable formats for data feedback, developing an improved version of the NFIRS data collection form and streamlining the data collection process.

In addition, the Fire Administration will continue providing technical support and training to users through the National Fire Information Council (NFIC). Annual and regional workshops will provide users a forum to exchange information and to review innovations in data management and analysis.

Analysis of Major and Unusual Fires

This project will continue to partnership with the National Fire Protection Association (NFPA). Case studies developed from these analyses will be used in an Advanced Fire Strategies course to be offered by the National Fire Academy.

Kerosene Heating Survey

A national survey will be conducted to determine the magnitude of the fire problem related to use of portable kerosene heaters in the United States.

Special Studies and Reports

The Fire Administration will continue to commission the conduct and publication of special studies and reports on current issues facing the fire and rescue service as well as the annual assessment of the magnitude of the U.S. fire problem.

Firefighter Death Survey

A special study will be conducted to gather more accurate statistics on firefighter deaths and their causes. Data will be analyzed to determine how these deaths can be prevented and/or reduced.

We cannot respond to the Chairman for the Center for Fire Research about projects that would not be completed if no funding was provided for that program.

Mr. REID. Now, Dr. Lyons, if the Center is eliminated what plans have been made for transferring the programs that are being conducted at the Center?

Mr. KAMMER. There are no plans for transfering.

Mr. REID. Mr. Brown, are there any questions?

Mr. BROWN. Just bring me up to date a little bit, Mr. Villella, about what is the justification that is being presented for the elimination of the work at NBS. You may have covered that earlier, and I'm sorry if I missed it.

Mr. VILLELLA. Mr. Brown, I have not and I was not engaged—we were not engaged—in the decision to zero fund the Center for Fire Research.

Mr. BROWN. Yes.

Dr. Lyons, are you familiar with the justification for that?

Dr. LYONS. Mr. Kammer is.

Mr. KAMMER. Sir, I'm Ray Kammer. I'm the Deputy Director of the Bureau. The motivation, as I understand it, first of all, is to try and reduce the budget deficit. The rationale arises from the fact the administration draws a more conservative line with respect to what Federal responsibilities are.

The principal output, ultimately, of our research would be reflected in building codes and fire codes of various kinds. These are viewed as State and local government functions. The construction industry does benefit from the results this research through improved products. It's reasonable to suppose that they might be willing to support some of the university research efforts that exist in the country now.

Mr. BROWN. You are saying State and local government and private industry might be willing to support this?

Mr. KAMMER. That is viewed as a possibility, sir. It's not a——

Mr. BROWN. Were there any studies made to see if this would, in fact, occur?

Mr. KAMMER. No sir.

Mr. BROWN. Do you know of any similar proposals made in the field, say of law enforcement, to eliminate some of the Federal activities in that area also?

Mr. KAMMER. I'm not familiar with any, sir.

Mr. BROWN. I have no further questions at this point, Mr. Reid.

Mr. REID. A perfect time for you to come in. We're about to start another panel.

Thank you very much, gentlemen. We appreciate it very much.

I would just close this hearing by stating that I know each of you have a job to do and I think the administration's proposal to eliminate the Center for Fire Research is absolutely ridiculous. There is no justification for eliminating this, and if my voice in a 435-body means anything I'm going to do what I can to see those funds are restored. Thank you.

Mr. Chairman, I'll call the next panel up and then you can take over.

The next panel—Joint Council of Fire Service Organizations—there are a number of people appearing. Those that will make presentations are: Louis J. Amabili, chairman of the Delaware State Fire School, and Martin Grimes, vice president, External Affairs, National Fire Protection Association.

Mr. Amabili is accompanied by Chief Charles Kamprad; Romeo Spaulding; and Harold Schaitberger who will respond to questions from the members—if any questions arise.

Mr. Chairman.

Mr. WALGREN. Gentlemen, let me apologize for not being here at the start. In this gathering of witnesses we have grouped a number together that are really separate and individual parts. I would like to deal with the joint council first and then deal with the testimony from a voluntary fire protection organization—the National Fire Protection Association.

This grouping was made in the interest of time but I do want you to know the committee has time. We are very prepared to hear, in full detail, the comments and observations that each of you, from your organizations, would like to make. I understand that Mr. Amabili, the chairman of the Delaware State Fire School would have a prepared written statement. Others who would have prepared written statements should understand they will be made part of the record and will be printed in full at this point in the record.

Let's start with Mr. Amabili and then we will turn to comments or observations that the other gentlemen from the International Association of Fire Chiefs the Black Professional Firefighters and the International Association of Firefighters might have.

If you would, Mr. Amabili, please proceed as you feel most comfortable. Either summarizing or presenting the written statement. We are very pleased you are here and as I said, your written statement will be made part of the record. Please proceed in communicating with your views to the committee.

[The biographical sketch of Mr. Amabili follows:]

LOUIS J. AMABILI, DIRECTOR
DELAWARE STATE FIRE SCHOOL

Louis J. Amabili has been Director of the Delaware State Fire School since its inception in November 1964. He is a graduate of the University of Delaware and has been affiliated with the fire service since 1947. He has been actively involved in both state and national activities.

Director Amabili has gained national recognition for his participation and contributions to the fire service. Activities included serving on the President's National Commission on Fire Prevention and Control (1971-1973), which authored the report "America Burning", serving as a delegate on the Joint Council of National Fire Service Orgnizations since 1972, a member of the Fire Officer Professional Qualifications Committee (NFPA-1021) since 1973, president of the International Society of Fire Service Instructors from 1973 to 1980, Chairman of the prestigious Fire Department Instructors Conference in 1979 and 1980, a charter member of the Board of Visitors to the National Fire Academy since 1978 and currently serving as its vice chairman, chairman of the International Association of Fire Chiefs Training and Education Committee since 1978, elected to a three-year term on the Board of Directors of the National Fire Protection Association in 1980 and recently elected to serve as chairman of the Joint Council of National Fire Service Organizations for calendar year 1983.

Director Amabili received the International Fire Service Training Association award for outstanding achievment in fire service training in 1975 and awarded the Order of the First by Delaware Governor Pierre S. duPont IV in August 1980.

STATEMENT OF LOUIS J. AMABILI, CHAIRMAN, JOINT COUNCIL OF NATIONAL FIRE SERVICE ORGANIZATIONS, ACCOMPANIED BY ROMEO SPAULDING, INTERNATIONAL ASSOCIATION OF BLACK PROFESSIONAL FIREFIGHTERS, CHIEF CHARLES KAMPRAD, INTERNATIONAL ASSOCIATION OF FIRE CHIEFS AND HAROLD SCHAITBERGER, INTERNATIONAL ASSOCIATION OF FIREFIGHTERS

Mr. Amabili. Thank you, Mr. Chairman. The written testimony is for the record. I do not intend to read it, I do want to make, on behalf of the council, some summary comments. First of all, I would like to point out, during the past year the members of the fire service and the FEMA officials have developed a much improved working relationship which was a concern at hearings last year in Congress. This was accomplished by both we and the people from FEMA getting together in an effort to establish a working dialog, and that has been accomplished.

We have also noticed during the past year that the Director of FEMA, General Giuffrida, has indicated a greater interest and support for the fire program. When the U.S. Fire Administration was saved by the Congress and proposed to be moved to the Emmitsburg campus, we at the joint council, supported that move for the cost effectiveness; for the better coordination between the Fire Administration activities and the National Fire Academy activities. We have cooperated very closely with the working group in attempting to identify those program areas that would best address the problems as was indicated in the opening statements. The group at the Fire Administration was very responsive to our imput, and as a result of that we developed a program plan which is, in fact, part of the testimony.

We have worked very closely with the National Fire Academy, as well, in providing input and supporting their efforts in the delivery of training programs.

One of the concerns is the oversubscription, if you will, and the fact problems were being created by the success of the National Fire Academy. I was in Memphis yesterday at the fire department instructors conference, and we held a board of visitors meeting—we held an open forum whereby the instructors from all over this country had an opportunity to come in and talk to us. Two major issues that were brought to our attention was the admissions problem, in relation to people who cannot get into the academy because it is full, and, it was mentioned earlier, the volunteers expressed a concern for the need for new field programs.

Also, in the written testimony we have presented an expansion of the progrms in terms of 25 full-time positions, and an additional $3.85 million with the breakdown—because we recognize the need for this additional work. We also recognize the fact that the Congress and the President are attempting to hold the line on the budget. We, as members of the council or as a joint council, are not seeking authorization for additional funds at this time, even though we have identified some of the problem areas that we think need to be addressed. We are here to ask the committee to reauthorize the Federal Fire Prevention and Control Act to the previous level of $22 million. This council is also aware of the good work being done by the Center for Fire Research and supports the reauthorization of that agency within the Department of Commerce, at least to the level funding, however, we support that not at the expense of losing any other fire dollars in the other parts of the program. So, very briefly, Mr. Chairman, that capsulizes the testimony I prepared for you, and we'll be glad to answer any questions you may have.

[The prepared statement of Mr. Amabili, and a written statement of Chief Kamprad follow:]

Joint Council of

National Fire Service Organizations

Joseph M. Redden, Secretary
Batterymarch Park, Quincy, MA 02269

STATEMENT OF
LOUIS J. AMABILI, CHAIRMAN
JOINT COUNCIL OF NATIONAL FIRE SERVICE ORGANIZATIONS
IN SUPPORT OF THE REAUTHORIZATION
OF THE
FEDERAL FIRE PREVENTION AND CONTROL ACT (PL93-498)
BEFORE THE
SUB-COMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
MARCH 16, 1983

JCNFSO
FMANA • IAAI • IAFC • IAFF
IFSTA • IMSA • ISFSI • NAFSA
MC of IAFC • IABPFF • NFPA
NVFC

The following organizations are members of the Joint Council and each has the Chairmanship in the year indicated: 1980 — International Association of Black Professional Fire Fighters; 1981 — National Association of Fire Science Administrators; 1982 — International Association of Fire Chiefs; 1983 — International Association of Fire Fighters; 1984 — International Society of Fire Service Instructors; 1985 — National Fire Protection Association; 1986 — International Fire Service Training Association; 1987 — International Association of Arson Investigators; 1988 — Fire Marshals Association of North America; 1989 — Metropolitan Committee of IAFC; 1990 — International Municipal Signal Association; 1991 — National Volunteer Fire Council.

Mr. Chairman:

My name is Louis J. Amabili. I am Director of the Delaware State Fire School, Immediate Past President of the International Society of Fire Service Instructors, Vice Chairman of the Board of Visitors to the National Fire Academy, a former member of the Presidents National Commission on Fire Prevention and Control and currently serving as the chairman of the Joint Council of National Fire Service Organizations.

As chairman of the Joint Council it is indeed a pleasure to submit testimony in support of the reauthorization of the United States Fire Administration and National Fire Academy within the Federal Emergency Management Agency. This testimony is presented on behalf of the eleven member organizations of the Joint Council as listed herein:

Fire Marshals Association of North America
International Association of Arson Investigators
International Association of Fire Chiefs
International Association of Fire Fighters
International Fire Service Training Association
International Municipal Signal Association
International Society of Fire Service Instructors
Metro Chiefs of the International Association of Fire Chiefs
International Association of Black Professional Fire Fighters
National Fire Protection Association
National Volunteer Fire Council

Prior appearances before authorization committees were not as harmonious as this hearing is expected to be. You are to be commended Mr. Chairman for inviting the Jount Council representatives and FEMA officials to sit at the same table during this important hearing. We believe this exemplifies the spirit of cooperation that has been developed between FEMA and the fire service during the past twelve months.

As each day passes FEMA officials learn more about the nation's fire problem and the need to provide cost effective fire related programs to keep life and property loss from escalating. FEMA Director Louis O. Guiffrida is to be commended for his increasingly personal attention to the fire program and the improved recognition and visibility of the fire programs within the Federal Emergency Management Agency. Recognition must also be given to Fred J. Villella, Associate Director for Training and Education, for his efforts in establishing an amicable and effective communication network between the fire service leaders and the FEMA officials.

I will not present to you as part of this testimony the facts and figures about life loss, property loss and the magnitude of the injury problem caused by fire. These statistics have been presented at previous hearings and are available to you. These statistics represent the past. Instead, this testimony will reflect the present and the future.

The United States Fire Administration recently restructured within the Federal Emergency Management is divided into four offices: Fire Policy and Coordination; Firefighter Health and Safety; Fire Prevention and Arson Control; and Fire Data and Anaysis. The Government Affairs Committee (GAC) of the Joint Council worked very closely with the USFA Working Group to establish priorities for each of these program areas and help guide the allocation of resources towards the primary mission of improving fire safety in the United States. Although the role of GAC was advisory in nature, the Working Group and FEMA officials were genuinely interested, cooperative and responsive to the many suggestions offered.

The program plan, endorsed by the Joint Council of National Fire Service Organizations includes a number of priorities and programs for each office within the Fire Administration:

OFFICE OF FIRE POLICY AND COORDINATION

Priorities for this office include overseeing the management and administrative activities of the Fire Administration and conducting programs which impact on fire and rescue service management practices.

Initiative for FY'83 include:

Improvement of NFIRS -- The aim of this project is to determine from the users' perspective, how to improve the National Fire Incident Reporting System (NFIRS) and how to make data collected through the system more accessible and useable at the local level.

Review of Fire Administration Historical Accomplishments -- A review will be made of Fire Administration accomplishments in terms of carrying out mandates of the National Fire Prevention and Control Act of 1974 as amended. Purpose of this review is to ensure programs undertaken by the Fire Administration in the future follow through in meeting mandates of the Public Law without duplicating work already done. In addition, this review will serve as the basis for recommendations for updating language in the Public Law.

Public/Private Sector Partnerships -- The Fire Administration will examine and document esisting public sector/private industry partnerships to address fire prevention-related problems which can serve as models for similar activities in the future.

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Long-Range Plan -- A new 5-year plan for the Fire Administration will be developed.

OFFICE OF FIREFIGHTER HEALTH AND SAFETY

Priorities for fire fighter health and safety include assisting in the development of improved protective clothing and equipment, establishing preventive programs, and improving diagnostic and immediate care procedures for fire victims.

Ongoing programs for FY 1983 are:

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Project FIRES -- Through grants to the International Association of Fire Fighters and to 14 cities across the United States, this project is a continuation of research, development and testing of an improved turn-out suit for structural fire fighting. During FY 1983, a model suit is being field tested by firefighters on the job. Design deficiencies identified by users in these tests will be corrected and incoporated into the prototype for a second series of field tests. Data from the final field tests will be analyzed and published.

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Fire Service Safety Officer Guide and Manual -- As a resource to fire departments creating the position of Fire Safety Officer, the Fire Administrations will codify work by a variety of organizations covering applicable standards, references sources and suggested practices.

OFFICE OF FIRE PREVENTION AND ARSON CONTROL

Priorities for this area include developing a pro-active program for fire safety codes and improving arson information management.

Ongoing programs are:

Arson Information Management Systems(AIMS) -- AIMS is an ongoing information system providing for the exchange of economic, social, and criminal justice information among law enforcemnt agencies, investors, bankers, and state and local anti-arson groups. During this fiscal year, USFA plans to determine whether state-of-the-art data management and infomration processing technology are being used by AIMS. An evaluation component will be integrated into the system to analyze the system's effectiveness. A specific city will be selected for study and development of a model program.

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An evaluation system will document and validate the program's effectiveness in reducing juvenile firesetting incidents.

Federal Arson Task Force -- The Federal Arson Task Force consists of representatives from various federal agencies with responsibilities or interests relating to arson. Chaired by FEMA, the Task Force serves as a forum for these agencies to exchange information on current and proposed programs.

In addition to regular bi-monthly meeting of the Task Force, the Fire Administration will host during the year short resident seminars at the National Emergency Training Center (NETC). Outside guest speakers and experts in the field will be invited to contribute to this exchange, providing a wider range of information and greater visibility to the effort.

New initiatives include:

Codes -- Much work still remains to be done in the area of code unification and standardization. The Fire Administration will work with organizations that develop fire standards and encourage more private sector involvement in code development and implementation. The aim of this project is to build on previous work related to code administration and enforcement done by the Fire Administration and to provide local officials with the knowledge and skills necessary to develop a strong, pro-active code process at the local level.

Residential Sprinkler Program -- This is a multi-year, phased project which builds on technical work already accomplished in cooperation with fire-related organizations and the private sector under Fire Administration sponsorship. Initiatives in this area will be aimed at encouraging an awareness on the part of the public and business and industry of the benefits of and technical improvements available in residential sprinklers and by promoting their adoption and use.

Smoke Detector Survey -- Information will be gathered to provide current statistics on smoke detectors in the U.S. including how many are in use, average costs, maintenance costs and problems, and their effectiveness and efficiency. In addition, an assessment of the effectiveness of existing local/state legislation mandating use of smoke detectors will be made.

Teleconferencing -- During 1983, the Fire Administration will explore opportunities for using teleconferencing as a means for transmitting and exchanging information on arson.

Arson Resource Center -- Through the Learning Resource Center at NETC, arson information will be compiled and disseminated on request. Data gathered by the Fire Administration to date will be supplemented by current information from other sources to provide a contralized national resource on the arson problem.

Arson Computer Project -- This project will introduce and encourage the application of microcomputers to the arson problem.. Potential program directions include encouraging attendance at the Academy's new microcomputer courseand tracking innovative programs started at the local level as a result of this training. In addition, information will be gathered to evaluate the effectiveness of computers as a resource for addressing the arson problem.

Rural Arson Project -- This 3-phase study will identify the rural arson problem in the U.S.; suggest strategies to mitigate the problem; and measure the success of those strategies.

OFFICE OF FIRE DATA AND ANALYSIS

Priorities for this office are to ensure effective fire data collection on a national basis; to develop a data bank of timely, accurate and retrievable information; and to continue analysis of major and/or unusual fires.

Ongoing projects are designed to meet these objective:

NFIRS Grants -- To ensure the collection of accurate fire data throughout the United States, second-and third-year NFIRS grants to states/localities already committed to participation will continue. Overall, the NFIRS program will focus on upgrading the quality of current data and making it more readily available at the local level.

Technical Improvement and Support -- Working with FEMA's Office of Information Resources Management, the Fire Administration is continuing to collect, process and feed back to users data on the U.S. fire problem. Initiatives in this area will be aimed at developing more useable formats for data feedback, developing an improved version of the NFIRS data collection form and streamlining the data collection process.

In addition, the Fire Administration will continue providing technical support and training to users through the National Fire Information Council (NFIC). Annual and regional workshops will provide users a forum to exchange information and to review innovations in data management and analysis.

Analysis of Major and Unusual Fires -- This project will continue in partnership with the National Fire Protection Association (NFPA). Case studies developed from these analyses will be used in an Advanced Fire Strategies course to be offered by the National Fire Academy.

New projects include:

Kerosene Heating Survey -- A national survey will be conducted to determine the magnitude of the fire problem related to use of portable kerosene heaters in the United States.

Special Studies and Reports -- The Fire Administration will continue to commission the conduct and publication of special studies and reports on current issues facing the fire and rescue service as well as the annual assessment of the magnitude of the U.S. fire problem.

Fire Fighter Death Survey -- A special study will be conducted to gather more accurate statistics on fire fighter deaths and their causes. Data will be analyzed to determine how these deaths can be prevented and/or reduced.

While the major thrust of the Joint Council's efforts during the current fiscal year were devoted towards helping to re-establishing the program priorities for the United States Fire Administration, the working relationship with the National Fire Academy continued. The co-location of the Fire Administration at the National Fire Academy campus in Emmitsburg should further enhance the working relationship between the fire service and FEMA, USFA and NFA.

Statistics for the National Fire Academy will not be presented as part of this testimony. They, too, are available to your committee if desired. However, note should be made that the successful delivery of quality courses both on campus and in the field is causing a major admissions problem resulting in a large majority of applications received being rejected because of classes filling up nearly a year in advance.

While the fire programs (USFA and NFA) are both effective and cost effective, they still lack the personnel and financial resources necessary to meet the needs of the fire service and to make the desired impact on the nation's fire problem. With this in mind the Joint Council had planned to appear beforethis committee to request 25 additional full time equivalent positions and 3.85 million dollars in additional funding for the USFA and NFA as follows:

A. National Fire Academy:	
(1) Field Program Division	
200 additional Field Programs and 8 FTE's	600,000
(2) Resident Program Division	
Conduct 1, two week program in each of 50 states and 8 FTE's	900,000
(3) Conduct 6 National Teleconferences on fire	300,000
	1,800,000
B. United States Fire Administration:	
(1) Firefighter Health & Safety Division USFA	
* Toxic environment detection device for firefighters	250,000
* Firefighter Health & Safety program development and delivery through NFA	300,000
* Research & Development and data collection activity in the area of ropes, escape devices, escape breathing apparatus, descent devices	300,000
* 5 FTE's	250,000
(2) Fire prevention and arson control implementation of fire safety and protection program including high rise, smoke detectors and residential sprinklers and 1 FTE	500,000
(3) Emergency Medical Services Program:	300,000
* Provide administrative and technical support for the development and implementation of basic and advanced life support systems in fire departments.	
* Provide an EMS resource center for fire department administrators and EMS system managers	

* Provide EMS management courses through the NFA.	
* 3 FTE's	150,000
	2,050,000
	3,850.000

However, in keeping with the spirit of the President and the Congress, the Fire Service respects the proposed FY'84 freeze and pledges its support in curbing inflation and keeping the federal budget in line. Therefore, we support the entire FEMA budget submission and spepifically request the reauthorization of the Fire Prevention and Control Act to the previously authorized level of 22 million dollars.

The Joint Council is also aware of the important work being conducted by the Center for Fire Research at the National Bureau of Standards and supports the position that the Center for Fire Research of the National Bureau of Standards be authorized and level funded within the Department of Commerce for FY'84 so long as the funding in no way reduces the recommended funding of any other federally funded fire program.

On behalf of the Joint Council I thank you for the opportunity to present testimony.

INTERNATIONAL ASSOCIATION OF FIRE CHIEFS • INCORPORATED

STATEMENT

OF

CHIEF CHARLES KAMPRAD

PRESIDENT

INTERNATIONAL ASSOCIATION OF FIRE CHIEFS

IN SUPPORT OF THE

REAUTHORIZATION OF THE FEDERAL FIRE PREVENTION
AND CONTROL ACT

BEFORE THE

SCIENCE, RESEARCH AND TECHNOLOGY SUBCOMMITTEE
OF THE
HOUSE SCIENCE AND TECHNOLOGY COMMITTEE

MARCH 16, 1983

Mr. Chairman, I am Charles Kamprad, President of the International Association of Fire Chiefs (IAFC) and former fire chief of St. Louis, Missouri. The IAFC is a professional association representing the nation's career and volunteer fire chiefs who are responsible for directing local governments' fire prevention and control activities, emergency medical services and emergency response to disasters. I appear before you today to request the reauthorization of the Federal Fire Prevention and Control Act of 1974.

Organized in 1873, the International Association of Fire Chiefs long has recognized that the fire problem can overwhelm the capabilities of local fire departments. The history of tragic fires and disasters has convinced our members that a collective and cooperative effort on the part of local, state and federal governments is necessary to combat the fire problem.

At issue today is the federal commitment to fire protection. The nation's fire chiefs, the entire fire service community and the U.S. Congress have worked for many years to create and maintain a federal focus on the nation's fire problem. The U.S. Fire Administration, the National Fire Academy and the Center for Fire Research have met these needs. These important federal agencies deserve to be reauthorized.

The nation's fire problem continues to be serious and deserves federal involvement. The following point should be considered when identifying an appropriate federal fire focus:

- The nation's fire problem demands a separate and identifiable agency, within the federal government, which will commit its total resources to assisting the existing fire protection community to serve the public needs and interest on a day-to-day basis.
- The public interest can be served best only if unwanted fire is recognized as a continually occurring problem. The day-to-day aspect of this problem, its magnitude and its effects are vastly different from the problem of intermittent disasters.

- The national focus must deal directly with, and be responsive to, the state and local fire protection community.

- The fire technology programs must be continued with concentration on solving current problems. An example of a project of vital importance and promise that already has been initiated is the development of newer and safer protective clothing for fire fighters.

- The National Fire Academy must not be subordinated to any other part of FEMA's programs. The fire programs should receive the highest degree of priority in keeping with the continuing magnitude of the fire problem. Through the academy and its system, new and transferrable technology, results of research and sound practices can be spread nationwide.

- There is a potential decrease of emphasis on fire safety and prevention with respect to the small fire incident which can occur in a disaster-oriented agency such as FEMA. The home is cumulatively the most dangerous to human life. Residential fires claim approximately 6,000 persons annually. These fires are not spectacular and often property losses are low. Nevertheless, it is the homeowner and individual family that suffer the most often from fire. Private residences are at the heart of the fire problem. The priorities needed here are vastly different from those required for a potential hurricane or earthquake, and these must be kept in proper perspective.

The IAFC has been engaged for many years in activities to define clearly the legitimate federal role in local fire protection. Fire prevention and control is accepted as a local responsibility. The U.S. Fire Administration (USFA) was created by Congress at the urging of the American fire service to provide a critical, coordinating cost-effective linkage among all federal, state, local, and private agencies and organizations responsible for fire prevention and control. This is still, and should continue to be, the primary function of the USFA.

The members of the IAFC, therefore, believe that the U.S. Fire Administration and the National Fire Academy should remain a major and distinct element of the Federal Emergency Management Agency. Ane we believe a strong organizational relationship is necessary between the Federal Emergency Management Agency, the U.S. Fire Administration and the Center for Fire Research to effectively mitigate the fire problem.

Since the creation of the U.S. Fire Administration, the IAFC has had opportunity to work closely with the fire administration, the National Fire Academy and the Center for Fire Research. This relationship has been one of mutual support for the benefit of the public and the fire service. We believe it is essential that dialogue be maintained between the fire service and the U.S. Fire Administration and FEMA.

Members of the IAFC participated in meetings with FEMA staff to effectively utilize the resources of the U.S. Fire Administration. We appreciate the opportunity to express our programmatic concerns for the fire service. Consequently, the IAFC supports the four program areas identified for the fire administration: Fire Fighter Health and Safety, Fire Prevention and Arson Control, Fire Data and Analysis, and Fire Policy and Coordination.

The initiatives envisioned under the Fire Policy and Coordination Office will greatly assist fire department officers to manage more effectively. An improved data collection and analysis effort will provide important fire loss information and experience to local fire departments. This is the type of federal activity that can have a positive impact at the local level.

Death and injuries suffered by the nation's fire fighters continue to be the highest of any occupation. Continued research into the development of fire fighter protection equipment and breathing apparatus is critical. The Fire Fighter's Health and Safety Office of the fire administration will provide resources for physical fitness programs, procedures to assist emergency personnel to develop diagnostic protocols for fire-related injuries and the management of safety procedures to be used for fire fighting.

Arson continues to present a severe threat to the nation's cities and rural areas. Death, injury and property loss from arson are an everyday occurrance in our society. Many fire chiefs state that arson fires represent

25% of the reported fires in their communities. The fire administration office of fire prevention and arson control has our wholehearted support.

In addition, to anti-arson measures, the fire prevention office will continue to examine fire and building codes, sprinkler systems and smoke detectors for residential properties. The IAFC considers this activity to be important in our attempt to provide safe occupancy for our citizens.

The office of fire data analysis should be considered as the basis of all of the fire administration's activities. Accurate and reliable data is absolutely critical in order to design effective counter measures to mitigate the fire problem. Data relating to fire fighter death and injury can be used to develop effective safety measures for fire fighting. Efforts to reduce death and injury to the nation's fire fighters should be a top priority for the fire administration.

The IAFC believes the programs identified by the fire administration will provide useful products and services to assist the nation's fire service to combat hostile and unwanted fire.

The National Fire Academy continues to provide quality outreach and resident education and training for the fire service. The IAFC supports the executive development curriculum and the specialized training programs. Our only concern is that the demand for these courses far exceeds the current delivery resources.

The International Association of Fire Chiefs is a founding member of the Joint Council of National Fire Service Organizations and concurs with the Joint Council statement. We believe that the current program initiative of the U.S. Fire Administration and the National Fire Academy could be increased if adequate financial resources were available.

On May 4, 1973, the National Commission on Fire Prevention and Control released its report, America Burning. This report was based on approximately two years of effort by fire service professionals, public management officials, the media and Members of Congress. I believe that the findings remain valid and the recommendations sound.

If additional financial resources were made available, this report continues to provide a blueprint to reduce the nation's fire problem.

Of particular concern to the International Association of Fire Chiefs is the Center for Fire Research in the National Bureau of Standards. Established by the Federal Fire Prevention and Control Act of 1974, we believe that this research activity is essential to the well-being of the public and the nation's fire fighters, and is necessary.

Clearly, the Federal Fire Prevention and Control Act of 1974, under Section 8 - Technology Development Program, Section 12 - Review of Codes and Section 18 - Fire Research Center, identified research into fire and associated areas as a primary role of the federal government. We are convinced that fire-related research is a legitimate federal activity and should be continued. Since fire research is a specialized area, I doubt that the private sector can replace the research activities now being conducted at the Center for Fire Research.

The following is only a partial list of the fire research center's activities which the International Association of Fire Chiefs would like continued.

- MAJOR RESEARCH EFFORTS DIRECTED AT REDUCING FIRE DEATHS AND INJURIES. The U.S. has the highest fire death rate in the world.
- FUNDAMENTAL RESEARCH ON FIRE AT U.S. UNIVERSITIES. Since 1976, the center has supported virtually all such fire research programs after taking over the former National Science Foundation Fire Research Program. The center operates major programs on sprinklers, smoke control, smoke detection and building design.
- WORK ON COMBUSTION PRODUCT TOXICITY WHICH ACCOUNTS FOR 90 PERCENT OF ALL FIRE DEATHS. The center supports nearly all the U.S. research in this area. There are still no accepted means of measuring, interpreting or reducing the toxic effects of fire.

- RECENT HIGH LOSS-OF-LIFE FIRES (THE MGM GRAND HOTEL IN LAS VEGAS, NEVADA AND THE STOUFFER INN IN NEW YORK) UNDERSCORE THE INADEQUACY OF EXISTING FIRE TESTS. New methods for flame spread and heat release are necessary to cope with the different burning behavior of construction and decorative materials. The center is the principal laboratory for development of these methods.
- THE ONLY CENTRAL U.S. FIRE RESEARCH LABORATORY FOR FIRE PROTECTION OFFICIALS AND INDUSTRY. The center provides laboratory work and technical assistance to more than 100 standards-writing and code committees engaged in fire protection. Almost none of these have laboratory facilities or technical staffs. CFR fire test and test method development facilities have provided important and continuing services to industry and other agencies of government for over 70 years.

In supporting the continuation of the fire research center, the IAFC would encourage a formal relationship between the center and the U.S. Fire Administration regarding the development of research priorities. The exchange of information between the research community and the fire service is essential to mitigate the fire problem and prevent needless civilian and fire fighter deaths and injuries.

In light of the important programs, training and research provided by the U.S. Fire Administration, the National Fire Academy and the Center for Fire Research, the members of the International Association of Fire Chiefs support the reauthorization of the Federal Fire Prevention and Control Act.

Thank you for this opportunity to present the views of the IAFC to you.

Mr. **Walgren**. Thank you, very much, Mr. Amabili. Let me ask the other gentlemen appearing with the joint council, whether there's other thoughts or emphasis that you would like to give to the subcommittee. I would encourage you to give us any thoughts you might have because this is one of the few times that we have a chance to get together and talk in a way that we can go back and look at a record and actually deal with these ideas and subjects that you see more closely than we do.

So I would like to address a general question and invite your comments on what shortcomings you sense in the national effort over the last year and where do you think we should be placing the more emphasis?

Mr. Spaulding.

Mr. **Spaulding**. Thank you, Mr. Chairman.

I guess when you speak of shortcomings one of the first thoughts that comes to mind is the projected budgeted dollar figure. Of course, we are dealing with that area here today. The programs that the U.S. Fire Administration has embarked on has been, for the most part, a pioneering effort. As your know, this is a young agency and the concerns that I have relative to it were raised by the chairman of the joint council which covered its admission policies and other programs. One of the things that I visualized as we worked on this was that we needed to develop long-range goals, along with short-range goals.

The programmatic areas that have been developed at this time lends itself to that area. It would give the Fire Administration a vehicle to work from whereby it could begin to address the problem areas as they relate to the Nation now while addressing the fact that America is still burning. Keeping in mind this fact, even though we have stringent fire codes across the country as related to smoke detectors, we are still experiencing somewhere in the neighborhood of about 80 percent of all fire casualties occurring within facilities where there are no smoke detectors. Keeping also in mind the fact that minorities are still burning up at the highest rate of any people in this Nation are some of the major concerns that we are looking at.

Pulling these concerns together under the programmatic areas that we have addressed here, we'll attempt to address them in such a fashion that will demonstrate our efforts to make positive strides to: No. 1 look at the data that is necessary to develop a new area that is called teleconferencing, whereby, we can begin to bring together within a short timeframe, the data that is developed across the Nation and begin to impact on the programs that are developed at the academy, to the end that we can develop a viable means of addressing this problem with emphasis on reducing the fire loss problem and the fire problem as it affects this Nation. No. 2 we are presently in this particular presentation trying to develop a visionary aspect of the fire service whereby this particular body can provide to the Fire Administration the type of working relationships that will assist them in carrying out the developed programmatic areas. One of the improvements developed, I think, if you can recall 1 year ago the fact that this organization was somewhat struggling against the Fire Administration, is the elimination of this friction. We were trying to get our programs and priorities together. Since that time we have gone back to the drawing board and sat down together. Instead of coming before this body divided, we've come before you united. From this position, I think we can begin to make the type of impacts that are necessary to have the necessary data and results from across this Nation to show that the U.S. Fire Administration is indeed on the right path; and furthermore, that the Congress in their response to this approach would be of such that the general public would applaud across this Nation.

Mr. **Walgren**. Let me ask—you mentioned the past divisions in approach and so does Mr. Amabili in his testimony. What was the source of those divisions? What were the different perspectives that were brought before and how have they been resolved?

Mr. **Amabili**. Well, a year ago, Mr. Chairman, we were here trying to save the Fire Administration when the Administration, much like the Center for Fire Research, was slated for zero funding, so we were here in an advisory role, if you will, with those officials. As I mentioned earlier, the Congress did mandate that that Fire Administration program would continue at a $4.15 million level, and since that time the—Mr. Fred Villella and the others—others involved in the fire program have worked very cooperatively with us to develop these type of programs as mandated by Congress.

Mr. **Walgren**. It's my understanding that during this period of time there's been a major reduction in personnel effort in the Fire Administration. Over the last year a reduction from something—from 50 some to 20 some—as the Administration has attempted to wrestle this into the form that they would like to see it. What is your view of the impact of that change?

Mr. **Amabili**. Even though the dollars and the people were reduced, Mr. Chairman, I think, working glove and hand with this organization, I think we have been able to at least prioritize those program areas that will have the greatest impact. The other part of it, I think, is the fact that when it moved out to the Emmitsburg Campus, even though the reduction was from somewhere around $8 million to $4 million—the net program dollars available because of the less cost of operating out there, as opposed to Washington—there are actually more program dollars to do some of the work.

All of the positions have not been filled. They are still working in somewhat of a transition mode in developing, as Mr. Spaulding indicated, a new program as well as looking forward to continuing in the future. Even though it appears a drastic cut, and it is a drastic cut, Mr. Chairman, I think, at this point in time, we feel that with the dollars and resources available that they are moving ahead as well as can be expected.

Mr. **Walgren**. Other comments, Chief Kamprad?

Chief **Kamprad**. I'm Chief Kamprad, I'm formerly Chief of St. Louis Mo., and presently president of the International Association of Fire Chiefs.

In comment to the cost of the reduction in personnel of the National Fire academy, what I feel has hurt us to a great extent is the elimination of the outreach training program. It was commented on earlier about the number of oncampus students. The facility is restricted to what its capacity is. I would certainly like to see the

U.S. Fire Administration and the National Fire Academy funded to a point where we could have the satellite programs or regional training. In a department like the fire department in St. Louis, I've been able to send possibly 30 of my officers to Emmitsburg. Around St. Louis there are 47 fire departments. Right within that community they could have a training program and have the availability of possibly 100 students without the expense of travel to anyone.

The loss of those instructors on a satellite program is a false economy, in my opinion.

Mr. WALGREN. Yes.

Mr. Schaitberger.

Mr. SCHAITBERGER. Mr. Chairman, first of all, if I could, for the record, correct my name to Schaitberger.

Mr. WALGREN. We apologize.

Mr. SCHAITBERGER. Those papers aren't long enough to get it on there.

First of all, I would like to convey the International Association of Firefighters sincere appreciation to your leadership, this subcommittee, the full committee and its chairman. There is no question in our mind had it not been for your commitment, and a strong commitment of the Congress, we would be sitting here today asking to renew a Fire Administration rather than to reauthorize it because we came very close to losing it.

As for our satisfaction in the amount of dollars provided in the programs that are being conducted—within the dollars that are available now I agree that the administration has been cooperative and has come a long way over the last year in working with the fire community. But I will have to say it is far too little; that some 8 years ago this Congress and the same Joint Council felt—and the Commission of 10 years ago—that it may take as much as $100 million to really begin to attack this Nation's fire problem.

We never reached those levels. We never came near reaching those levels and have consistently, over the years, been reduced in the amount of dollars that have been dedicated toward the Nation's fire problem.

Close to our heart is firefighter safety and health. And again, a lot of work has been done and a lot of good work has been done by the administration but certainly not enough. We still experience the highest death and injury rate of any profession in this country. We still, in too many areas of this country, are using the same personal equipment and apparel that our fellow colleagues used 50 and 60 years ago. The equipment development has been still slow to come. The associated occupational hazards that we believe are involved in our profession—the toxic gases, the environment that we're continually working in—there hasn't been enough work and study as to what is the accumulated effect on an individual over a long period of time. What effect does it really have one one's body. Those areas still need to be addressed further with more dollars and with a further commitment.

Mr. WALGREN. You mentioned those areas that still need to be addressed. Can you measure it all or give the subcommittee any experience over the last year what was lost—what was not done that we anticipated doing or could have anticipated doing because of this administration change——

Mr. SCHAITBERGER. We had some commitments that—of course, Project Fires which was a project in cooperation with NASA in the development of wearing apparel—I believe the subcommittee may recall that we actually brought some of the items in that they had been working on. There still needs to be further work in that area. There's been some developments but there certainly hasn't been enough development in distribution where it is now really being used. Self-contained breathing apparatus; we need more commitment and further development in that area. We're still all over the country wearing breathing apparatus which weighs 30 and 35 pounds and only allows us 30 to 45 minutes duration, which really isn't the case, because anyone who has ever worked as a firefighter and worn a device like that, knows that a 30-minute breathing apparatus if you get 20 minutes out of it you're doing good. So we need some type of device that will allow us to be able to work longer in that environment.

There has not been enough money to go as far forward in those areas as we would have hoped over the years.

Mr. WALGREN. Other responses from the Joint Council members to the general question?

Mr. SPAULDING. Just in continuation I would like to say I think one of the most important areas that the fire service has begun to look at here in recent years is that of public fire and burn safety education. The things that were mentioned by my colleagues here are just part of the internal aspects of this area that is related to those who deliver this service. However, we in the fire service profession have a responsibility to educate our public. One of the reasons why we have such a traumatic fire problem in the United States is because that particular entity has not been allowed to be developed.

We have not moved from the apathetic mode to the empathetic mode as it relates to the fire problem. What I mean here is that what we do too often is react, and we need to go to the scientific approach in developing programs that will take us into a mode where we will be ahead in the game instead of behind. I think that's what these programs and this type of testimony is directed to.

Mr. WALGREN. Let me recognize Mr. Reid, at this point, for other thoughts.

Mr. REID. No questions.

Mr. WALGREN. Mr. Brown.

Mr. BROWN. Thank you very much, Mr. Chairman, and gentlemen it's a pleasure to see you here this morning. Having sat through these hearings over the past 10 years I have the same sort of feeling that you do about the situation that confronts us today.

There's a vast amount of work that remains to be done out there and we're not approaching it as vigorously as we should. One possible example of that came to mind when Mr. Spaulding used the word "teleconferencing" which happens to be another area that this committee is interested in. The stimulation of the new technologies in communication through computers and so on to benefit the people of this country. I wanted to ask you to elaborate a little bit, Mr. Spaulding, on what you are thinking of when you use that term. You know we have the technology today, not only to establish a computer data base in every fire department in this country, which would enable us to control resources and have a knowledge base at our fingertip to improve our firefighting; we have the capability to link those data bases throughout the United States, from every fire department. We have the capability of doing that not only for computer networking but for video networking so that we can actually have video links for coordination purposes, data exchange, whatever purposes that we need.

My question is: How far has the fire services, in general, gone in conceptualizing how they might be able to use these technologies to improve the firefighting posture of this country?

Mr. **Spaulding**. Certainly we are aware of it and the U.S. Fire Administration is aware. They are in the process of looking at trying to develop that type of training mode there. All of the things that you stated there are very much a part of what we have looked at in the fire service as being a part of teleconferencing. The scope that is allowed in this particular entity is almost beyond the imagination as to what could be done in this area. For once, the instant access to data across the Nation, on a national basis, could be used internally. It could be used for training. It could be used for all sorts of things. It could be used for presentations here to substantiate budget needs—to show how what you are doing is impacting upon the Nations fire problem. All sorts of things. These are some of the areas that we are focusing looking on as we are talking about teleconferencing. The technology is here and why shouldn't we capitalize on it?

Mr. **Brown**. Obviously, it would be difficult for any one fire department, even a large one, to initiate or even to develope conceptual plans for this on their own. This seems to me to indicate another important role for the Federal coordinating and research mechanism that we have created here. Is that your concept?

Mr. **Spaulding**. Yes, sir. That's why I mentioned it here in this forum. So that you would be aware of it and to know that we are aware this is need but yet we don't have the dollars to do it. I think together with the ideas here and the money there we can do it.

Mr. **Brown**. It's interesting that you should bring the matter up because just last month the Air Force, which is a highly centralized organization, apparently let a contract to upgrade and innerconnect every computer that they have on a global basis. It was about a $1 billion contract according to the press. I haven't examined it in detail but what it does is permit every Air Force installation in the world to be innerconnected by video links for the purpose of connecting their computers at each installation. Would the fire service like to have something like that?

Mr. **Spaulding**. Sure. We certainly would.

Mr. **Schaitberger**. Mr. Brown, another area that this type of technology could be used, as I am sure you are aware, we are faced now with many exotic metals, hazardous materials of all types, radio activity is now an everyday occurrence, not only in the transportation of but found in locations whether it be schools, laboratories, medical offices. The ability to be able to have data available instantly on the effects of a particular material or chemical or metal and what proper extinguishing agent should be used and what hazard you can expect to the individuals involved in that particular incident, what type of side affects. That's the kind of information that really could be phenomenal if this type of capability were ever to come about on a national basis.

Mr. BROWN. Obviously, again, this is not something that any one fire department could do but every fire department would have to have access to it on a reasonable basis from some central data bank or collection of data banks to have that information.

Chief KAMPRAD. If I might, Mr. Brown, comment. I sent an officer from St. Louis to Kansas City to participate in a health communications program developed through the efforts of FEMA. The Denver, Colo., fire department prepared the training program. Then they televised it through their network, and it was picked up in various cities throughout the country. So the effort and study in this regard is underway.

Mr. BROWN. A rather noted future stinker by the name of Buckminister Fuller envisioned this about 40 years ago. You're a little late catching up with him.

Chief KAMPRAD. Like everything else.

Mr. BROWN. The fire service has a problem here which is of the generic nature. That is, the fire service nationally is a collection of relatively autonomous and relatively small units which collectively have difficuly in aggrating their needs—looked at as a market they have difficulty aggrating their market for a service or in the example you mentioned, protective clothing and equipment. One reason that there isn't a vast research program going to meet this need is because there are literally thousands of different customers whose needs are uncertain and poorly conceptualized. Sometimes so you don't get the resources channeled into the efforts to improve it in fashion that you would.

As I say, this is a generic problem. For many years we had a similar situation. Perhaps we could use a comparison of the various electric utilities around the country. They are fairly large organizations but they didn't do their own research, or not enough of it, because they thought that their suppliers or somebody else could do the research for them and it's only within the last few years that they've set up their national research organization—Electric Power Research Institute. The question is: Whenever you face a highly decentralized and uncoordinated market like this, how do you get the central direction and focus that you need? That's the problem that we've been trying to approach with the centralized fire research and similar kinds of activities. Now, the question is: Have we passed the need for this? Can we go back and rely upon the various individual efforts or the efforts of your suppliers or whatnot to fill the gap here or do we need to continue with our effort here to focus on the totality of our problems as a Nation and attack them in a coherent way? I'm going to assume that your testimony is that we need to continue with the latter course and I won't belabor that any further, Mr. Chairman. Thank you.

Mr. Walgren. Thank you, Mr. Brown.

Let me recognize counsel for the minority.

Ms. BACH. Thank you, Mr. Chairman. I want to ask Mr. Amabili a question with regard to the Center for Fire Research which we discussed with the previous panel.

My question is: Whether it be on a small scale or an expanded scale, could you provide to the committee other sources of fire research in fire protection, whether it be equipment or environmental hazards? We had asked the previous panel if they could indicate to us other places that research is going on; could you kindly do that for us?

Mr. AMABILI. Did you want me to respond or send it in to you?

Ms. BACH. If you can respond at this point and then you might want to add to it for the record.

Mr. AMABILI. We're in support for what the Center for Fire Research is doing. As a matter of fact as a former member of the National Commission the Center for Fire Research was, in fact, established as part of the act to bridge that gap from the pure research, as we knew it at that time, and to extract from that pure research those types of things that they developed that would be applicable to the more applied science-type of application. Tests are being done by Underwriters Lab, but that's more a testing organization as is FM, even though they do some research as opposed to what the Center for Fire Research is doing. I'm not sure I've answered your question.

Ms. BACH. So are you saying that there really are no other sources of this type of research going on outside of NBS's Center for Fire Research?

Mr. AMABILI. No major centralized source that I'm aware of. And if someone here on the panel would like to respond to it they certainly may.

Mr. Spaulding has indicated they are the only ones doing the research in toxicity, which certainly is an important aspect of the fire problem.

Ms. BACH. What about State and local areas? Is there any research of any significance going on there?

Mr. AMABILI. No. That's why we had the Federal Fire Prevention Control Act passed into law. Maybe to respond to the last statement of Mr. Brown, if the fire program would discontinue it would be like taking a 10-year backwards step in history as far as I am concerned. A lot of things have happened—a lot of good things have happened to this country and to the people of this country as a result of the efforts of the U.S. Fire Administration and National Fire Academy. NBS prior to 1974 and the CFR since 1974——

Ms. BACH. Just a final question. Do you foresee in the future anyone taking on this research? And would it be appropriate for someone outside of the Federal Government to proceed with this type of research?

Mr. AMABILI. I'll answer this on a personal basis. No. I don't see that in the future—any private organization taking it on and investing the type of dollars that need to be invested to do the type of research that is needed. That's a personal opinion.

Mr. SPAULDING. I was just going to say that I think history will dictate in an area like that, that somehow or another, there has to be some cohesiveness about what is going on. If it's left to private industry, a lot of other factors would come into play which would result in all sorts of things coming out and some results could be tilted one way or the other; to the detriment to the country and would also not be cost effective. It can be according to whatever that particular company or private entity is looking for. With the Federal controlling this area, you would be looking out for the best interest of the country and effecting a measure of cost effectiveness. That's my interjection, and why I feel it should stay with the Federal Government.

Ms. BACH. Thank you.

Mr. WALGREN. Gentlemen, thank you very much.

We appreciate very much——

I'm sorry. Mr. Brown.

Mr. BROWN. Could I interject just a couple more points here. I and this committee as a whole have had an interest in this technological question that I brought up earlier about how we can better utilize the technological progress this country is making to meet very concrete needs that face the country.

I wanted to raise the question that given the advances that are possible using communications and computer technology in the fire service, if you gentlemen don't see the possibility that this would tremendously enhance our overall capability of responding to national emergencies of the sort FEMA, Federal Emergency Management Agency, was chartered to serve. Obviously the core of FEMA's mission is to respond to a a possible military confrontation. But that just as obviously is going to involve huge outbreaks of other kinds of disasters.

There's going to be fires. There's going to be destruction of all kinds. It seems to me the technological capability to coordinate response and to evaluate damage and so on represented by this kind of communication capability would have broad applicability. Am I correct in this?

Mr. SCHAITBERGER. Yes. In responding to any kind of a disaster situation.

Mr. BROWN. With the fire service being at the center, of course, of any response that might might be necessary.

Mr. SCHAITBERGER. Not only at the center, Mr. Brown, but really in the forefront. This is something that we have brought to the committee over the last few years and that is this question of first responder and FEMA's overall role. Whether the disaster is natural, manmade, fire, storm, the fire department is typically the first on the scene and has the initial responsibility in coordinating those efforts and in that communication network.

Mr. BROWN. Yesterday we heard testimony with regard to the earthquake disaster—earthquate hazard mitigation—programs. Obviously earthquakes impacting a populated area are going to have some of the same effects. They are going to disrupt all of our fundamental lifeline structures; they are going to cause huge fires, as they did in every case that we have examples of. A capability to evaluate and respond on a regional and national basis could become a huge asset in handling that kind of a situation.

I mentioned the example of the Air Force, and to some degree, what the other services are doing at the present time in developing this kind of technological coordination. It seems to me if we are going to move forward in this area in the part of the fire service, somebody is going to have to exert a little push. I'm wondering if it wouldn't be one of the things the Council might undertake—to conceptualize, we'll say a research program that could lead to the formulation of a integrated national networking system for the fire services in this area. Is that sort of an activity within the scope of what the Council might do. I don't mean design the system or anything like that. But identify the need and the benefit in order to create a little pressure behind getting some action in this area.

Mr. AMABILI. We could do this, and maybe we are doing it, in cooperation with FEMA and the Fire Administration, in fact, some of these concepts have already been discussed and we are starting to move in that direction to take advantage of the technology that does in fact exist.

Mr. SPAULDING. Also, Mr. Brown, if I may add. The Emergency Management Institute at the Federal Training Center is designed just to do that. It's bringing in a concept to the fire service called integrated emergency management, whereby those particular things that you just articulated will be brought into play and thereby coordinate the whole effort and including the fire service in that particular response.

Mr. BROWN. I sense a certain problem in getting the top management in FEMA to be responsive to this. If you could articulate this a little bit better in the fire service and communicate some of that to us here in the Congress, who might be able to interact with the higher levels in FEMA, we might be able to make a little bit more progress in that area.

Mr. SPAULDING. OK.

Mr. BROWN. I would suggest that is something you might think about over the next year and maybe we can avoid this kind of crisis that we are facing today.

Thank you, Mr. Chairman.

Mr. WALGREN. Thank you, Mr. Brown.

The Chair would like to recognize Mr. Boehlert.

Mr. BOEHLERT. No questions.

Mr. WALGREN. Gentlemen, thank you very much for your testimony on behalf of the Joint Council of Fire Services. We appreciate your coming to the subcommittee and we'll look forward to reviewing your testimony with the other members.

Mr. AMABILI. Thank you, Mr. Chairman.

Mr. WALGREN. The subcommittee would now like to hear from the National Fire Protection Association, and we have with us today the vice president of External Affairs, Martin Grimes.

Mr. Grimes, we appreciate your coming and making yourself available to the subcommittee. Your written statement will be made part of the record. Please feel free to go forward and share your perceptions with the subcommittee on behalf of the National Fire Protection Organization.

[The biographical sketch of Mr. Grimes follows:]

MARTIN E. GRIMES

Martin Grimes has held the position of Vice President for Policy and External Affairs of the National Fire Protection Association since 1980. Grimes joined the staff of NFPA in late 1969 and, until 1976, headed the Public Protection Division of the Association. This Division is responsible for all services of the NFPA in the public sector of fire protection, including fire suppression, fire prevention and enforcement.

From 1976 to 1980 he was Assistant Vice President responsible for NFPA's Government Affairs activities in Washington, D. C. and at state and local levels.

Grimes has been actively involved in professional fire protection activities for 40 years.

Between 1940 and 1943, Grimes served in the wartime British National Fire Service. From 1943 to 1946 he served in the Royal Marines. In 1946, Grimes returned to serve in a number of major fire departments, rising through all ranks until he was Senior Fire Protection Officer of a large metropolitan county.

In 1960, he was appointed Commissioner of Fire Services in Bermuda to reorganize the fire protection services of Bermuda. This operation involved the fire services, fire, building and electrical code development and application. Using a blend of European and American equipment, techniques, codes and standards, he successfully completed this in 1969. He was awarded the Queens Medal for Distinguished Service in 1970 in recognition of his service to the British and Commonwealth Fire Services.

Grimes graduated from the British National Fire Service Staff College with honors in all subjects in 1952. He is a Fellow of the British Institution of Fire Engineers and has numerous other qualifications related to fire protection and public administration. He has received several awards for his work in fire protection, including the Fire Service Research Trust Prize in 1953.

As an expert opinion witness on fire, he has been involved in cases at all jurisdictional levels, both civil and criminal. He has lectured on most aspects of fire protection at colleges, universities and national conferences, and has served on legislative and standards-making committees. He has acted as consultant to several foreign governments and has authored numerous articles and reports related to public fire protection.

Grimes is the Secretary of the National Professional Qualifications Board for the Fire Service and has administered the professional qualifications system since it was established in 1972. He served on the National Fire Academy Training and Education Committee and was a director of IFSTA for several years. Grimes is also Secretary and Executive Officer of the National Fire Protection Research Foundation.

In his present position, Grimes deals with policy matters over the wide range of NFPA's activities and is also responsible for membership, conferences and general liaison of the Association. He has testified on many occasions before Congressional Committees on a wide range of matters related to fire protection and is intimately involved with the many important issues in fire protection that face the nation today.

STATEMENT OF MARTIN GRIMES, VICE PRESIDENT, EXTERNAL AFFAIRS, NATIONAL FIRE PROTECTION ASSOCIATION, QUINCY, MASS.

Mr. **Grimes**. Thank you, sir.

The written statement is really in two parts. The first part is generally regarding the Federal Fire Prevention and Control Act. The second one is on the specific item of the elimination of the Center for Fire Research.

On the first issue the NFPA has, as Mr. Brown is well aware, testified on the need for a Federal focus, and at times have been critical, since the introduction of that act, of some of the actions taken and the methods used. However, we must say that the current method of administration administering the act, and the way that the FEMA is performing is in accord with what we conceived as the original intentions of the act when it was first promulgated. I want to make that point because although I don't want to say too much on the subject, the fact is, we see them now working along identified priorities and in a cost effective manner, utilizing all the resources available that can best contribute to the resolution of the problems on which they are working. We think that this is the right way to go and the best use of the buck. The Federal buck.

I think there are some priorities, probably, but at the moment the channels on which they are working are the right ones. Maybe more dollars behind them, yes. But certainly they have identified the priorities.

Some achievements: Residential sprinkler system test. It is now possible to design a residential sprinkler system at low cost. This is due entirely to the imput given to this by FEMA, by the U.S. Fire Administration and the involvement of the Bureau of Standards Center for Fire Research.

Even as late as last fall there were some tests carried out in Fort Lauderdale on a very low-cost sprinkler water system for hotels; retrofit-type system. This was due to Federal action. We feel that they are working along the right lines. We would like to see more funds available to them but we think their methodology; their selection of priorities; and the way they administer these programs is along the right lines.

We further would like to reiterate that we've always maintained that the National Fire Academy is probably the best long-term promise for resolution of the fire problem because it gets to the local and State levels by training people and increasing the competence and the ability of those people to perform, so we want to see that program complete and intact and continue to grow in strength.

On the question of the elimination of the Center for Fire Research, and listening to the explanation this morning that this could be done in the private sector or by State and local government is hogwash. That's ridiculous. The Center for Fire Research picks up programs that industry cannot or will not support. State and local government are in no position to undertake the type of applied and pure research that is being done by the Center for Fire Research. It's not the sort of thing that a State government can do, that is set up the research labs and all the other facilities.

The Center for Fire Research is really doing exploratory research for use by others. Now, we produce some 200 codes and standards related to fire safety. Including the life safety code, sprinkler standards, and many others. Much of the fundamentals that are used in those standards come through the research at the Center for Fire Research. They do initial research that nobody else will touch. No one else will pick up. We want to see that continue. We think it's absolutely essential that it continue because the fire problem, although the trends in the late seventies indicated that something could be done about the fire problem, it is still here with us. We have some encouraging signs. This also partly due to the Federal Government's intervention. We're seeing a reduction in the loss of lives in residences—in the home. It's not great but it's there and it looks to be a trend.

The big campaign put on by the Fire Administration and other organizations, about 4 or 5 years ago, was really the thing that got people to buying smoke detectors and putting them in their homes. Also the development of smoke detectors and much of the work done at the Center for Fire Research on identifying the problems with the earlier smoke detectors that were produced.

But now we are seeing a reduction in the loss of life in the home and a lot of it is due, not all of it, to that fact that probably half the homes in the country are using smoke detectors. And they are cheap because of the improvements that were made and the research that was done some years ago. To abandon this sort of work at this time is ridiculous. We're seeing some results from the attack on the fire problem. Not much, admittedly, but some. We can attribute those to the work being done by the Federal Government and others, I don't exclude our other organizations in this credit. To see it go now is ridiculous. And the justification given that it can be done in the private sector is ridiculous. Private sector research has got to be related to a product. If they are going to put money into research it's got to be related to something that they are going to see a return on.

The sort of fire research that is done at the Center for Fire Research is that which no industry wants to pick up. They may want to fund some of the work that is being done. The toxicity question. That is a big heated problem right now primarily between two conflicting commercial interests. Those producing plastics and those that are not producing plastic but products that use something else. That's the real fundamental issue. It's being made a very critical problem for everybody and it's not one that can be lightly ignored. It's got to be resolved. We've got to find out more about toxicity.

Basic research on toxicity is being performed at the Center for Fire Research. Their protocols are now being used and picked up by other people as the beginning of the next stage. There was a question asked about who else is working on these things. Very little non-federal fire research is being done. There is some being done in universities and some commercial research. But it's a small, very narrow, area. It's not—they are not dealing with those problems that we would hope to see the Center for Fire Research continue to work on.

I put this pitch for them because I think it's absolutely essential that the Center for Fire Research continues and that they be funded and I don't accept the explanations of the administration that it can be done in the private sector or by State and local governments. That is unrealistic.

Mr. **Walgren**. If I could underscore your descriptions of those reasons.

You call them hogwash. You know, in my family, we always had a tradition of calling it "pure unadulterated hogwash." It goes back a long long time so I do respond to that word. Mr. Reid and I visited the Center not long ago and it makes a very deep impression on you when something is extremely valuable, and to think it would be lost for arbitrary budget reasons given the excesses in other areas of the budget, is just a crime of the first order. I do appreciate your underscoring that with such a direct word as hogwash—it really deserves to be called just that.

Don't let me interrupt. Please finish.

Mr. **Grimes**. I had really finished what I wanted to say.

I wanted to reiterate that we think that FEMA and the Fire Administration, the National Fire Academy must stay. They must continue. They must grow if economic conditions permit. We see the current level of funding primarily as an expediency that ultimately must change and there must be increased funding.

We also look at the funding in other aspects of Federal expenditures and see the amount of funding for the fire programs in FEMA to be somewhat out of relationship to some of the other money that is going to other programs.

On the other hand, we think that they are working in the right direction. We want to support them. We want to commend them for the methodology of using the best methods to use the money that they have available, albeit limited. We do want to see the Center for Fire Research continue and think it's absolutely essential for fire protection in this country. You will be hearing this morning about the international aspect. There are very few major industrial countries that the Federal Government doesn't pour money into fundamental fire research and give the impetus that way.

Private industry can pick up from some of the results, yes. But certainly not that basic research they are doing out there.

[The prepared statement of Mr. Grimes follows:]

NFPA®
"Moving Mankind Toward Safety From Fire"

NATIONAL
FIRE PROTECTION
ASSOCIATION
INTERNATIONAL

STATEMENT CONCERNING THE FEDERAL FIRE PREVENTION AND CONTROL PROGRAMS AS AFFECTED BY THE FY'84 BUDGET PROPOSALS

submitted to the

Subcommittee on Science, Research and Technology
Committee on Science and Technology
United States House of Representatives

by the

National Fire Protection Association
Batterymarch Park
Quincy, Massachusetts 02269

March 16, 1983

EXECUTIVE OFFICE: BATTERYMARCH PARK, QUINCY, MASSACHUSETTS, U. S. A. 02269 • TELEPHONE (617) 328-9290 • TELEX 94-0720

The non-profit technical and educational organization. To promote the science and improve the methods of fire protection and prevention; to obtain and circulate information on these subjects and to secure the co-operation of its members and the public in establishing proper safeguards against loss of life and property by fire.

The National Fire Protection Association (NFPA) supports the reauthorization of the Fire Prevention and Control Act of 1974. In providing support for the reauthorization of this Act and the activities of the United States Fire Administration (USFA) and the National Fire Academy, the NFPA provides the following brief background concerning the Association.

The NFPA, founded in 1896, is a nonprofit, technical and educational membership organization. It has remained the principal public advocate for fire safety since its inception. The Association's membership of over 32,000 is drawn from the many disciplines involved in, and concerned about, the national fire problem. NFPA is not a trade or industry association. No one group or interest is dominant. The only common membership denominator is a concern about fire safety. Members include fire service personnel, fire marshals, electrical inspectors and city managers; architects, engineers and educators; health care facility operators and similar groups from commerce, industry, insurance and the Federal Government.

One of the principal functions of NFPA is the development of more than 200 consensus codes and standards related to fire protection. They range from the Life Safety Code through the National Electrical Code, the National Fuel Gas Code and flammable liquids standards, sprinkler and similar equipment standards to those used for fire apparatus, fire fighter safety and professional qualifications. NFPA has many other functions including public education, technical advisory services, research and development, and data collection and analysis.

The NFPA is a founding member of the Joint Council of National Fire Service Organizations (JCNFSO) and supports the position of the Joint Council provided in testimony by the Chairman at this hearing.

The NFPA has provided testimony or statements for the record in support of the United States Fire Administration (previously the National Fire Prevention and Control Administration) at all of its authorization and appropriation hearings. While NFPA has been a strong supporter of the need for the United States Fire Administration and an effective federal focus on this Nation's fire problems, the Association has also provided constructive comments and voiced the Association's concerns regarding the policies and direction of the Fire Administration in the past. The NFPA would like to indicate to the Committee its support and approval for the present leadership and direction provided by the Federal Emergency Management Agency. The past items of concern to the Association that are now being effectively dealt with through the present administration of FEMA are:

- The emergence of cooperative programs which, in the intent of the enabling legislation, work with existing organizations already well established within the national fire community rather than supplanting the activities of these existing efforts.
- The need for continued recognition that fire is a state and local responsibility and federal involvement should be in the form of support and assistance to state and local programs rather than through intrusion and take-over of functions traditionally held by such governments.

- There be no diminution of the intent and purposes of the Federal Fire Prevention and Control Act of 1974.
- Appropriate emphasis be placed upon programs dealing with solutions to the everyday community fire problems and caution be exercised to see that this activity is not subordinated by other programs of lesser national ongoing need.
- That there be strong support and continuation of the programs of the National Fire Academy and that these fire programs receive the highest priority in keeping with the continuing magnitude of the national fire problem.

The NFPA desires to compliment FEMA on its recognition of the capabilities of ongoing programs at the state and local level, as well as within the private sector. The Federal Emergency Management Agency has initiated cost-effective, cooperative programs with state and local agencies and other organizations in the true intent of the Fire Prevention and Control Act.

NFPA is encouraged by the direction being taken by the Federal Emergency Management Agency and feels that even more involvement and usage of ongoing programs can ultimately benefit the objectives of the Fire Prevention and Control Act of 1974. As the Nation's principal public advocate for fire safety, the NFPA strongly supports the programs of the United States Fire Administration and the National Fire Academy as provided for in the FY'84 budget under consideration.

Mr. WALGREN. We certainly appreciate that testimony.

Let me ask for a little more development of this conflict between the plastic and the nonplastic products with regard to toxicity. Since you are intimately involved in fire issues, I am curious about what you see developing in that area.

Mr. GRIMES. I have to be very careful because our organization is involved in suits from both sides of the picture.

We're being accused both ways and I would be very careful not to make too many statements as that is a critical stage. The whole question of toxicity has been raised, just ignoring the remarks about commercial interest, that it has been increased since the advent of some of the manmade materials. The fact is, and I really am expressing a personal opinion because we do have a committee on toxicity which is at the moment—working—exploring this in more detail. The fact is that fire has always produced toxic gases. It's produced them in lethal quantities, primarily carbon monoxide but other gases. The question really today is: Are some of the new materials that are being used contributing more toxicity or contributing to the change in the physiological effect on the human being. This is really what we need identified right now, is in fact, the toxicity question different now? Apart from which the whole question of how you deal with toxicity in fire codes has got to be addressed. That's one we are trying to address right now. Trying coming up with formulas that apply to toxicity in a fire, in much the same way that over the years formulas of the spread of flame over the surface of a room, the fire loading of buildings years ago, that determines the fire resistance required of a building. Now we need to have some factors and some formulas that can be applied by code enforcers to determine just how much of particular materials can be used in a building.

There's a long way to go. There's a lot of problems and many variables.

Mr. WALGREN. That will probably have a very direct impact on a number of private sector interests if various materials are found to be less safe than others.

Mr. GRIMES. Yes. It will have a tremendous effect—already, just in the electrical cable and wiring area it's having impact, and this is where the argument is at the moment in commercial areas.

Certainly if it broadens out to other materials—other products—it will have tremendous effects. It's something that ought to be taken and dealt with in a reasonable manner and not start off a witch hunt on a product until we are really sure it is the culprit in the picture.

Mr. WALGREN. Thank you. Mr. Brown. Mr. Boehlert.

Mr. BOEHLERT. Thank you, Mr. Chairman.

Mr. Grimes, I would like to thank you for your vivid description. I would like to identify with two words you used, as the chairman did, "hogwash", that's easily understood and "ridiculous". I think it is hogwash to assume that the work being done by the Center for Fire Research would be handled by State and local governments. They are in no position to do so, as much as they might wish to do so. And private sector, obviously, the incentive is lacking there.

In terms of the National Fire Academy. I would like to ask you: Is there any breakdown on the use of that by volunteer as opposed to professional firefighters, and let me hasten to add I almost avoid saying volunteer firefighter. I prefer to say nonpaid because they are very professional and do a magnificent job all over this country. Are the volunteer firefighters using the National Academy for training?

Mr. GRIMES. I would have to defer on that question to Mr. Villella or Mr. Donovan on the actual numbers. I am sure they will have them and will be prepared to provide them. Our indications are the courses provided are suitable for use by the volunteer firefighter. Certainly in the standards that are developed for performance in firefighting they make no distinguishment between the paid and the volunteer. Obviously the National Fire Academy must offer courses suitable for the manager of a large fire department, who's handling a budget of several hundred million dollars, in some cases, which is somewhat different than that provided for the man who has a small fire department in the country. But I believe they do offer the courses. I believe they are attending. I'm sure they have figures that would confirm that they can make available. Certainly, it should be available to them. Their outreach program is the one that would mostly reach the bulk of the volunteers. That is the one put on through the State and local governments.

[Breakdown use of National Fire Academy by volunteer and paid firefighters:]

RESIDENT PROGRAMS DIVISION

FY 82 STUDENT STATUS

CAREER	2,619	(63%)
VOLUNTEER	220	(5%)
COMBINATION DEPT.	1,099	(27%)
OTHER*	192	(5%)
TOTAL	4,130	(100%)

OTHER: Includes federal employees, private industry, allied professionals and foreign.

RESIDENT PROGRAMS DIVISION

FY 83 STUDENT STATUS

CAREER	2,138	(64%)
VOLUNTEER	118	(4%)
COMBINATION DEPT.	834	(25%)
OTHER*	230	(7%)
TOTAL	3,320**	(100%)

*OTHER: Includes federal employees, private industry, allied professionals and foreign.

**As of 5/26/83 (YTD)

FIELD PROGRAMS DIVISION

FY 82 STUDENT STATUS

CAREER	4,882	(46%)
VOLUNTEER	4,478	(43%)
COMBINATION DEPT.	817	(8%)
OTHER*	328	(3%)
TOTAL	10,506	(100%)

*OTHER: Includes federal employees, private industry, allied professionals and foreign.

FIELD PROGRAMS DIVISION

FY 83 STUDENT STATUS

CAREER	2,839	(46%)
VOLUNTEER	2,719	(44%)
COMBINATION DEPT.	495	(8%)
OTHER*	98	(2%)
TOTAL (YTD)	6,151**	(100%)

*OTHER: Includes federal employees, private industry, allied professionals and foreign.

**Projected balance FY'83 = 4,400

Mr. **Walgren**. Mr. McCurdy.

Mr. **McCurdy**. Thank you, Mr. Chairman. I would just like to thank and express my appreciation to the all panel and all the people that are here today testifying on this issue. I support efforts to reduce America's alarming fire problem. There are some people, not only from Oklahoma, but all over the country who are very concerned about fire safety. Fire is a national problem and I again applaud the Chairman for taking time to hold this hearing.

We're getting buzzed again, for a second bell, for a vote on the rule, so we're going to have to leave here.

Mr. **Walgren**. All right. Thank you very much. We certainly appreciate that straight-from-the-shoulder view and it's going to have a great effect. One of our greatest problems is trying to sort through the hogwash that comes from many parts of our Government. I just don't think in good conscience that in an area where life is involved that these programs can simply be zeroed out, because of some budgeteers whim as to a bottom line that he's trying to achieve without any regard for the actual contribution that that program makes toward life and safety. I am hopeful that the Congress this year is going to be taking a much different approach than the Congress did in the first session, in terms of adopting line item recommendations on a budget level from the administration. We do appreciate your perspective and your observations on that function.

At this point we do have a vote on the floor and we will adjourn for 10 minutes and we'll resume with a panel from universities at that point.

[Recess.]

Mr. **Walgren**. Witnesses to come forward: Prof. Richard Bland, Pennsylvania State University, who is the former chairman of the National Fire Prevention and Control Commission; Chief Jack Lee from Charlotte, N.C.; Prof. John Bryan, chairman, Department of Fire and Protection Engineering, University of Maryland.

Gentlemen, we are pleased that you could come and make yourself available to the subcommittee.

Your written statements will be made part of the record. Please feel free to summarize or communicate to the subcommittee as you best feel would be effective. Let us then start with Professor Bland.

Welcome to the subcommittee.

[The biographical sketch of Prof. Bland follows:]

VITA

RICHARD E. BLAND

- Born September 19, 1925;
  Warren, OH

Address and Telephone

- Business 814/865-5467

  Applied Research Laboratory
  The PA. State University
  Post Office Box 30
  State College, PA 16801

- Residence 814/237-7262

  435 E. Irvin Avenue
  State College, PA 16801

Education

- Hiram College; Hiram, OH
  B.S., 1948
- University of Michigan
  M.S., Physics, 1949

Pertinent Information

- Registered Professional Engineer in PA
- Member, Society of Fire Protection Engineers
- Chairman, National Commission in Fire Prevention and Control (Public Law 90-259)
- Member, Governor's Commission in Fire Prevention and Control, Commonwealth of PA
- Principal Investigator, A State Strategy for Destructive Fire Control, PA Emergency Management Agency, (Now in printing)
- Active member, Alpha Fire Co., State College, PA (having held offices of Assistant Chief and Corporate Vice President)

- Member, Fire Limits Committee, Council of Governments, State College, PA
- Board of Trustees National Fire Protection Association Research Foundation, Washington, DC
- Board of Advisors for Program in Fire Safety, Worcester Polytechnic Institute
- Former Chairman, National Academy of Sciences Evaluation Committee for the Center for Fire Research, Bureau of Standards
- Chairman, Nuclear Reactor Safeguards Committee, PA State University, University Park, PA
- Member of Committee on Accreditation of U.S. Fire Academy

Honors and Awards

- Fire Protection Man of Year, Society of Fire Protection Engineers
- Cy Barrish Award for Human Services, PA State University
- Distinguished Guest Lecture - Australian Fire Protection Association - Melbourne Australia

STATEMENT OF PROF. RICHARD BLAND, PENNSYLVANIA STATE UNIVERSITY

Prof. **Bland**. It's a pleasure to be here. This committee has a perception that intrigues me, particularly Mr. Brown's.

If I look back over the last decade, since the Fire Prevention and Control Act of 1974, I am disappointed. My observation is that the U.S. Fire Academy is the tail wagging the dog of the U.S. Fire Administration. Conceptually, the U.S. Fire Administration was to be an agency responsible for three elements that the Commission felt essential if we were to meet the charge of this Congress. That charge was to significantly reduce life and property loss from destructive fire. The three elements were a data system, a knowledge base, and an academy function.

A data system is essential to guide research, to establish needs, and to build a proactive system; rather than a reactive system. The data system at the present time is stalemated in argument of who can do it best. The present data system tells us, how many residences, mercantile buildings, and schools burned but it doesn't establish a needs hierarchy to which we can respond through research and dedicated programs. Nor does it have the content to give us a positive feedback. If you detect a need—and then develop a knowledge base to approach that need, there must be within the data system some way to feed back whether the approach was productive.

The data system is stalemated and will require very careful study before it is mature.

The second necessary element was a knowledge base. A data base is part of a knowledge base. The data base suggests needs; the sorting of these needs gives direction to research; research fills in the knowledge in response, to the needs.

The Commission saw two needs. One was technology; we were pleased that the Congress set up the Center for Fire Research. Technology is a continuing need; it will be a need as long as there is recognition that fire, a combustion process, is a natural phenomenon. Fire is an occurrence of nature. You cannot legislate it out of existence; you cannot conjure it out of existence; nor do we want to. It is essential to our living. What you can do is control fire losses. Learning to control and manage the losses is a very real technological burden that demands the type of research that, has been ongoing at the Center for Fire Research.

There is however an area of research that, has been neglected. I will refer to that as soft science research. A very respected member of the Commission one time said there are three causes of fire: Men, women, and children. You have to understand human behavior better than we currently understand it if we are to prevent destructive fire. That, Mr. Brown, is the same problem you raised within the crime context.

You also raised a very interesting public safety issue. My disappointment with the U.S. Fire Administration is centered around what I preceive to be a loss of concern for the public. The decade has seen struggles for power, a great deal of rhetoric, and a loss of interest toward the public. It's the public that suffers the ravages of fire; it's their homes that burn; it's their automobiles. Fire is a true public safety issue.

I have presented, two areas that the commission thought should be treated as priorities. They are a mature data system and a research effort. A mature data system would probably take 30 years to put into place. In the research effort I suggested two aspects: technology and human behavior. I emphasize the human behavior needs by contending that this Nation's fire problem is about 25 percent technological and 75 percent economic, and social. We are not doing much in the behavorial, economic, and social areas.

The last of the elements where the commission saw a need was for information exchange. The chairman and a number of other people have spoken to the need for communicating to the grass roots; that was the concept of the National Fire Academy. The academy was a conduit for information.

Chapter 6 of America Burning spoke to the academy and was one of the shortest of its chapters. There was no discussion of bricks and mortar; when bricks and mortar came before the commission the discussions were emotional The word academy was used in the very broadest sense. An academy can be anything from a child care center to the prestigious National Academy of Sciences.

The commission did not define the academy; maybe that was an error. The academy was one of Outreach. How do you transfer the information being generated or assimilated at the Federal level back to the field. It is in the field that we will make progress in fire loss management.

Looking back at these 10 years I am disappointed in the American Fire Services' ability to put together a public safety program on behalf of the public. The fire service, as I use the word, includes the entire fire community. It is the architects, the builders, the architectural engineers, the craftsmen, of which the fire suppression forces, are but a part. And I think the Congress has to look to the total fire community as we approach the fire problem, the total community must be addressed by the academy.

As a result of, our own doing through mismanagement, vested interest, Congressional pressure, fiscal pressures and so forth, we have forced the academy into a parochial position.

As I look down the programs of the U.S. Fire Administration, they seem also to be parochial to the fire suppression services.

I would at this time, hope that the Congress, will reject the recommendation to terminate the Center for Fire Research. CFR is absolutely essential to the progressive growth in our knowledge; to disband it is a regression. And, I hope the Congress will ask the U.S. Fire Administration to present a program that represents an effort on behalf of the public. The objective is to reduce the loss of life and property from fire.

If you have any questions I would be most happy to attempt to answer them.

[The prepared statement of Mr. Bland follows:]

Testimony of R. E. Bland

before

The Committee on Science & Technology

The U.S. House of Representatives

March 16, 1983

In testimony before the Senate Committee on Commerce, Science & Transportation, the need for scientific and engineering understanding of the physics and chemistry of fire, fire growth and fire suppression was emphasized if we are to manage the Nation's destructive fire threat. The Center for Fire Research (CFR) at the U.S. Bureau of Standards is the responsible agency for such work under the Fire Prevention and Control Act of 1974. The CFR through in-house and sponsored research has provided a basis for reasonable codes and standards, significantly expanded the understanding of fire dynamics, developed a test program for combustion product toxicity, been instrumental in devising institutional fire safety systems, and maintains the most comprehensive technical library and reference system for fire.

On the basis of CFR past performance and the continuing need for fire related science and technology efforts, I ask that the recommendation to terminate the Center for Fire Research at the Bureau of Standards be rejected and that the Congress provide financial support at no less than the 5.8 million dollars requested.

Chairman Walgren's invitation to present testimony indicates this subcommittee will go beyond the consideration of the CFR to review the current and projected programs of the U.S. Fire Administration (USFA). I welcome that opportunity.

Since its inception the USFA has been made unstable by personnel changes, governmental reorganizations and budget threats. As a result, it has not attained the institutional maturity necessary or appropriate to its task. In its pursuit of governmental due process and in the attempt to accommodate the diverse and divided groups that assume to represent the American fire community, the USFA service responsibility and objectivity seems to have been lost.

The service aspects and objectivity requirements stem from a governmental obligation involving a natural threat.

The service responsibility rests totally in the fact that fire is a public safety issue parallel to those of crime and health. Fire is momentarily reoccurring; its time scales are from minutes to hours; its results are irreversible; it is a growing threat in our technological environment.

Fire loss management is an element of our economy. Costs associated with such matters as owner indemnification through insurance, building requirements, occupational safety, provision of mobile fire suppression equipment and manpower, and specialized medical facilities are borne by the public.

Fire is a natural phenomenon; it can be neither legislated nor conjured out of existence; the only choice is to control it.

Because fire is a natural and necessary occurrence, a level of risk must be accepted. Here is where we must become objective since our resources are limited.

The kernel of the fire protection question is cost vs risk or put another way, cost vs benefit. Costs are so readily collectible; estimates of the direct and indirect costs of fire in the U.S. approach 20 billions of dollars annually. Risk and benefit are probabilistic and judgmental; their quantification is more difficult. It is in the assessment of risk and the choice of beneficial alternatives that we find ourselves wanting.

To make such assessments we need:

1. a definitive experience base (data),
2. knowledge (understanding), and
3. a mechanism for information exchange (communication channel).

The National Commission on Fire Prevention and Control clearly saw these needs if it was to meet its goal. The goal, made clear by the Congress, was a significant reduction in life and property loss from destructive fire. The organizational structure proposed by the Commission and put in place by the Congress in 1974 was responsive to these needs.

I see no diminution of these requirements, hence a public hearing on the state-of-affairs in the federal focus on fire might explore past and projected actions in the context of those needs.

Need: A Definitive Experience Base

The National Fire Incident Reporting System (NFIRS) was an attempt to provide a statistically valid bench mark around which an effective and cooperative fire prevention and control program could be structured among all levels of government and the private sector.

There are data needs at all levels. Since fire incidents occur locally, the data source must be local. Given an uncounted number of fire departments within the U.S., a reasonable approach seemed to be encouragement at the State level. Assistance grants to States were envisioned as encouragement, a means of developing content and form, and a method for maturing a beneficial system. (An interesting aspect of fire data is information on ignitions that did not develop into "fires" - non-fire. What inhibited the growth of a specified ignition is an important question in fire loss management.)

The state of development of NFIRS is not clear. I suspect it is stalemated in an argument of who can do it best. It seems obvious that the user should structure raw data, perform analysis and evaluate its own needs as it formulates its responses.

For example, local governments should analyze for such as effectiveness in code enforcement, fire department resource allocation, demographic trends and as an evaluation of own programs.

States would be expected to tend toward more global references such as effectiveness of codes, transportation restrictions, insurance rate regulation, natural resource protection, feedback on initiatives and responsibilities under specific state legislation.

The Federal Government would analyze for such interests as fire safety experience under its interstate commerce mandate, indicators of research needs, and environmental protection and demographic trends.

In this day of automatic data processing, the success of such a system depends only upon content and entry of a coded input. The National Commission intended that the Federal Government would cooperatively (with incentives if necessary) devise and assist in positioning such a system.

To assume that the Federal level would collect the total data and analyze it in usable form for the state and local levels is unreasonable; it violates the concept of shared responsibility. To contend that any singular entity should be responsible is equally unreasonable. The unreasonableness stems from the varied needs and the scale of fire incidents.

I emphasize again the need for a definitive data base. A clear concise plan of action that puts a mature data system in place is a priority. Without it we will continue to drift in our objectives, respond to the contingencies of the moment and sway in a cloud of smoke.

The administration, management and processes of fire data collection, analysis and dissemination should be within government. At the Federal level, leadership toward such a system should be a major responsibility of the U.S. Fire Administration.

Need: Knowledge

A statistically valid data base is a part of the necessary knowledge.

In addition, two inseparable areas of research are required; they are technology and human behavior.

In technology we have made progress consistent with the level-of-effort. As examples,

- Early warning fire detectors are available at reasonable cost to both tenant and owners. Their quality and reliability has been paced by the test methods developed at the Center for Fire Research. State and local agencies have been successful in public information programs and many governments include such devices as a requirement in fire safety codes. The U.S. Fire Administration was an effective participant.

- Flammability standards have been adopted by a number of industries including household furnishings and clothing. Again, the Center for Fire Research has been instrumental in providing both the technology base and devising test procedures.

- Through its in-house efforts and support of research at academic institutions, the Center for Fire Research is making significant progress in mapping fire and toxic gas behaviors in ventilated enclosures. (Fire in a room or structure because of the doors, windows, heating, air-conditioning and air exchange systems is a fire in a ventilated enclosure.) Experimental validation of the analytic treatment at both full and reduced scales marks the progress. That is extremely encouraging and a significant knowledge contribution since it has the potential for bringing together the many facets of fire technology

- I am convinced through review of patents and the record of tests by the Underwriters Laboratories and Factory Mutual Research Corporation, that industry is paying growing attention to the fire resistance of its products. Such private efforts are paced by CFR fundings.

In contrast, human behavior research receives much less attention than its resultant fire impact warrants. Here again the Center for Fire Research, within the bounds of its charter, has pursued a better understanding through such efforts as its Facility Fire Safety Performance programs.

But, the concerns of human behavior extend far beyond the human habitat. The National Commission recognized that point and recommended the structure of the U.S. Fire Administration be such as to support an appropriate human behavioral effort. That was to be an important part of the research effort within the USFA.

That effort never really got off the ground and I see little in the current literature related to these issues.

Among the still current questions are:

What are the social parameters in increased fire incidence?

Does our social and economic system have incentives for fire, and if so, how can they be affected?

What information sources and methods efficiently and effectively carry fire safety messages to various sectors of our society?

What are the human engineering requirements of our appliances, machines, transportation and comfort environment that can reduce misuse and abuse?

How does the public perceive fire risk?

These and many others deserve at least an effort toward resolution.

Need: A Mechanism for Information Exchange

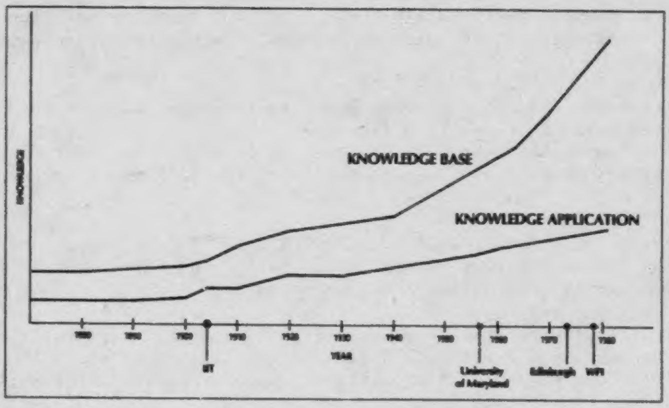
The National Commission on Fire Prevention and Control was a pragmatic group; it recognized that progress in fire loss reduction would be measured only in field experience. That field is 230 millions of people spread over 3,618,467 square miles. For these reasons, the effort would require active participation by all sectors of our society. An obvious objective was a system for information exchange that was equally and readily accessible, that was substantive, authoritative and responsive. It was also clear that the existing knowledge base was not being applied; an anticipated result of a coordinated effort would be to further increase that knowledge. The information had to be disseminated in applicable form if it was to be utilized.

That was the function of the U.S. Fire Academy. Few of the Commissioners were willing participants in discussions of bricks and mortar. Chapter 6 of America Burning, The National Fire Academy, was one of the shortest. Though the information exchange system was a matter of importance, the mechanics emerged amid emotions. No resolution in the time span of the Commission (2 yrs.) seemed possible. Further, effectively meeting the challange would probably best be served by an evolutionary process.

The word academy was carefully chosen to encompass a range of endeavors. An academy by definition and current usage covers the spectra from day-care-centers to the prestigious National Academy of Sciences. (The latter had a destructive fire committee and continues to hold relevant symposia concerned with building fire safety.) To be an effective conduit of relative information, the academy needed to communicate with the full fire related community.

The vehicles for communication were to be those already in existence; the possibilities included the long existing Cooperative Extension System of the USDA via the Land Grant Colleges and Universities, the Continuing Education systems and the public school system. Such methods assured state and local government participation and were locally accessible.

A specific example in transitioning knowledge to application is illustrated in the following figure.



The plot was taken from a pamphlet entitled In Response to a National Need: Fire Protection Engineering at Worchester Polytechnic Institute dated May 18, 1982. Authorship belongs to David Lucht the first Deputy Administrator of the USFA and Richard Custer a former researcher at CFR, now both with WPI.

The figure is a subjective illustration of the growth of knowledge in the technical and scientific aspects of fire protection. It indicates either our reluctance or lack of capacity to convert new information into a disciplined body of knowledge for use by the practitioners. For instance, no where is there a hardcover, scholarly textbook that treats the subject of fire behavior in an academic fashion. Only one academic institution will offer a certified fire protection engineering curriculum at the baccalaureate level (University of Maryland) and currently two are attempting programs at the graduate level (Illinois Institute of Technology and Worchester Polytech). Grants-in-aid and fellowship support at the graduate level are nearly nonexistent. I suggest such matters should be prime concerns of the U.S. Fire Administration through its U.S. Fire Academy.

There is a mood that leads toward directing criticism to the Fire Academy. That was exemplified in a recent issue of Fire Engineering where the curriculum and long student waiting list was placed in defense.

I understand the Academy's motivation toward establishing a clientel, its desire to utilize its housing and classroom facilities, and its allegiance to the concept of train-the-trainer. Those among other pressures force it toward looking collegiate as it offers courses for "credit," installs computer laboratories and offers Management I, II and III. The result is a parochical tendency toward the fire suppression forces. The fire suppression forces, though the most visible, are but one sector of the community contribution to solution of the fire control problem. It can be argued that the forces are capably positioned based on the availability of modern suppression equipment and extent of accessible training systems. There are admitted deficiencies, but American forces clearly and daily demonstrate their suppression capability at the local level.

Criticism of the U.S. Fire Academy seems to be unwarranted given what appears to be the status of the U.S. Fire Administration. Because of the turmoil that has surrounded the Federal focus on fire over the last decade, the Academy appears to be near the sole survivor; the tail may be wagging the dog.

This Congressional Committee is faced with a public decision. The question is the functional responsibility of the Federal Government in the public safety issue of destructive fire management.

I believe that the Federal level shares a responsibility with the other levels of government in our system. There are critical areas where the Federal level because of its global position, capacity and capability is uniquely qualified and thus obligated.

Among those areas are:

1. maintaining a statistically valid experience and data base,

2. providing a continuing research effort to extend the knowledge base, and

3. providing an academy function, recognized as authoritative, for the assimilation and disseminationon of knowledge and techniques applicable to reducing destructive fire loss.

Hence, I ask the Congress to reject the recommndation to terminate the Center for Fire Research and to authorize the funding necessary for a continuing threshold effort. Such an effort is necessary in reducing the Nation's fire losses.

Further, I ask the Congress as a part of this authorization effort to review the intent of the Fire Prevention and Control Act of 1974. If that intent remains valid, move to position the U.S. Fire Administration such that it can mature and function with recognized authority as the Federal Agency cooperating in destructive fire loss management.

Mr. **Walgren**. Thank you very much, Professor Bland.

Let's continue with the other witnesses and then we'll come back to discussion with the three of you.

Chief Lee.

[The biographical sketch of Mr. Lee follows:]

March 1983

JACK LEE, CHIEF - CHARLOTTE FIRE DEPARTMENT

Native, Born in Raleigh, N. C.

Resides with wife Wanda at 2233 Stonewood Drive

Daughter, lives with family in Lakeland, Florida, 3 children.

Son, lives with family in Savannah, Georgia, 2 children.

Member, Park Road Baptist Church, Choir Member.

Served in World War II with 104th Infantry Division.

Served in Korean Conflict with 92nd Engineer Searchlight Company.

Began Fire Service Career in North Miami, Florida upon returning from Korea in 1952. Advanced through ranks to Department Training Officer.

Appointed Training Officer of St. Petersburg, Florida, Fire Department in 1961, serving for 5 years.

Comprehensive Fire Service Background and completed courses in the following:

Fire Fighting Tactics, Florida State Fire College
Municipal Fire Administration, International City Managers Association
Municipal Finance Administration, ICMA
Municipal Personnel Administration, ICMA
Municipal Administration, Institute of Government, Chapel Hill
Fire Department Administration, SMU

Served on Board of Directors, Florida State Fire College, 1959-1962, last year as Chairman.

Appointed Chief of Fire Department, Oak Ridge, Tennessee in 1966.

Member and Past President, Atomic City Kiwanis Club

Vice President, Board of Directors, Youth Haven, Oak Ridge, Tennessee

Secretary, Member Board of Directors, Boys Club of Oak Ridge.

Appointed Chief of Fire Department, Charlotte, N. C. in October 1971.

State Vice President, Southeastern Division, International Association of Fire Chiefs 1970-71.

President, Southeastern Division, International Association of Fire Chiefs 1975-76.

Member, Board of Directors, International Association of Fire Chiefs Foundation 1976-78

Member, Board of Directors, International Association of Fire Chiefs - 1975-

Member, Finance Committee, International Association of Fire Chiefs 1976-77.

Director at Large, International Association of Fire Chiefs 1977

Member, Metropolitian Committee, International Association of Fire Chiefs.

1st Vice President, International Association of Fire Chiefs 1979-80

President, International Association of Fire Chief 1980-81 .

Member NFPA Committee, Fire Service Officer Qualifications.

NFPCA Long Range Master Planning Project, Advisory Committe.

Member, Evaluation Panel, Center for Fire Research, National Bureau of Standards 1976-82

Member, Board of Directors, Charlotte Council of Alcholism.

Affilliate Member, Carolina Chapter, Society of Fire Protection Engineers.

Member, Charlotte Civitan, Board of Directors 1976-79

Member, Advisory Committee Salvation Army.

Chief, Charlotte Fire Department, Retired 12/82

STATEMENT OF JACK LEE, FIRE CHIEF [RETIRED], CHARLOTTE, N.C.

Mr. LEE. Thank you, Mr. Chairman.

I offer testimony in opposition to the elimination of the Center for Fire Research of the National Bureau of Standards.

I might say that I worked 2 years with Professor Bland on the evaluation panel of the National Science Foundation for the Center for Fire Research, and he's always a tough act to follow and this morning is no exception. With your indulgence I'm going to summarize from my paper some of the remarks that I feel necessary.

As usual I couldn't find anything that Professor Bland commented to that I could take exception to. I support those remarks almost in their entirety.

I am a past-president of the International Association of Fire Chiefs, as well as past-chairman of the Joint Council of Fire Service Organizations. I served two terms on the evaluation panel for the Center for Fire Research. I say that to you to give you some idea of the direction from whence I come.

However, I am not here representing any of those groups. I'm here at the invitation of you Mr. Chairman, and I thank you for this opportunity.

It appears that the decimation of the Government commitment to, and involvement in fire safety, fire control, and fire research, is destined to continue until, in fact, the Center for Fire Research no longer exists. At the rate it is occurring its demise appears imminent.

My remarks are aimed specifically at the Center for Fire Research. I would like to say, that for me, the Center for Fire Research is to fire research much as Johns Hopkins University was to the medical field for many many years. You heard it said by others this morning that there was no organization; there was no specific bureau, there was no point on which we could turn other than Center for Fire Research for the solutions to fire research problems. That is true. There is no other agency that has that responsibility. In spite of the fact that our country experiences the greatest destruction by fire and by deaths, persons injured maimed, and property destroyed, of any country in the world. This in spite of the fact that we have developed the greatest fire suppression and state-of-the-art capability that money can provide. But we know so little about this source of energy and this menace. Yet we can be as unrealistic as we are at this time in spending billions of dollars to match strike capability in the event of a nuclear attack while, in fact, our very survival may depend upon our abilities to deal with fire and prepare for dealing with fire. Especially those of the nuclear variety.

I think it's important, once again, referring back to some of the comments and questions that were asked this morning.

My response when I asked Jack Snell, Director of the Center for Fire Research, to summarize the effect to research alone, if the center were abandoned. And I quote Jack when I say, grants totaling $2 million per year to 30 leading universities and non profit laboratories would be halted, and this would terminate our progress in developing scientific knowledge of the basic phenomenon. The involvement of the expertise of many universities and institutions would also be lost.

We referred to toxicity today, as we have talked about the Center for Fire Research, and its effect on the population, the environment, and firefighters. As a firefighter I assure you that some of the greatest problems we encounter, in providing fire protection to our communities, are those associated with the behavior of toxic gases and our limited ability to perform because of the inabilities of our self-contained breathing apparatus. We need to know more about this equipment and how to improve our capabilities in their use. Who is to say where the responsibility lies? We've asked ourselves today: Is it with industry or is it with Government? Is it the public or private sector? Who will maintain an appropriate awareness? At this point we do have a responsible Agency. If we eliminate the Center for Fire Research I'm not sure that we do. As a matter of fact, I would suggest, we do not. While chief of the Charlotte Fire Department I received a letter from the White House dated June 1, 1982, from which I quote excerpts for brevity.

> I commend you and your organization for your contribution to the development of an innovative quick reaction sprinkler head. Fire loss is of great concern to this Nation. This project is an outstanding example of what Government and private industry can achieve when working together to solve a critical national problem.

This was signed by President Reagan.

Certainly, fire, with its productivity and its consequences, cannot be left unattended, ignored by the Federal Government, and attended to by those who are motivated, or satisfied by profit.

Though it is not widely known, and I am on record with the evaluation panel at the Center for Fire Research, for increasing its visibility, the last several years have brought about a coordinated effort between industry, institutions and the U.S. Government. Together they have addressed the problems associated with the phenomenon of combustion in all of its forms. I suggest it is not too widely known in academia, certainly industry has little knowledge of it. And we have agreed that we need to make these efforts more widely known. How we have maintained such competent, highly qualified dedicated staff, at the Center for Fire Research, I don't know. During these years that I have served on the panel we've been faced with diminished resources and personnel and, in fact, each time that we have met with the panel, we have been forced to consider the efforts and the tactics that they have used in solving problems to stay alive and keep the center afloat as opposed to solving those problems dealing with the national fire problem.

It has taken years of effort on the part of many, in and out of the Bureau, to put together the brilliance that is found in the research and management team at the center. And Lord knows they are not attracted by the pay. But they are there. If Congress allows this center to be wiped out, gentlemen, I assure you such a team will not be reassembled in our lifetime.

Further, if some sense of permanence or security for the center can be arrived at, it will enhance our chances, in the future, of attracting highly, qualified scientists to these tasks and opportunities.

Fire suppression in our cities, towns, and rural areas is a local problem as are fire prevention, fire investigation, and fire education activities. The American Fire Service is in accord with this concept. Fire research, however, cannot be left to the folks at home. There's too much risk. Too much at stake. Fire research is a National responsibility.

Thank you for permitting me to address you.

[The prepared statement of Mr. Lee follows:]

TESTIMONY IN OPPOSITION TO ELIMINATION OF THE CENTER
FOR FIRE RESEARCH, PRESENTED TO THE SUBCOMMITTEE ON
SCIENCE RESEARCH & TECHNOLOGY ON MARCH 16, 1983, BY
JACK LEE, CHIEF OF CHARLOTTE FIRE DEPARTMENT, RETIRED.

GENTLEMEN:

MY NAME IS JACK LEE. I RETIRED AS CHIEF OF THE CHARLOTTE, N.C. FIRE DEPARTMENT ON DECEMBER 31, 1982. I HAD HELD THAT POSITION FOR ELEVEN YEARS, CULMINATING A 31 YEAR FIRE SERVICE CAREER.

TO SET THE STAGE AND CREDIBILITY FOR MY REMARKS, YOU MAY BE INTERESTED IN SOME OF MY PROFESSIONAL ACTIVITIES.

I AM A PAST-PRESIDENT OF THE INTERNATIONAL ASSOCIATION OF FIRE CHIEFS, AND PAST-CHAIRMAN OF THE JOINT COUNCIL OF FIRE SERVICE ORGANIZATIONS. IN 1981, I CONCLUDED SIX YEARS AS A MEMBER OF THE NATIONAL SCIENCE FOUNDATIONS EVALUATION PANEL FOR THE CENTER FOR FIRE RESEARCH. HAVING SERVED 2 TERMS I WAS INELIGIBLE FOR REAPPOINTMENT.

I WISH TO MAKE IT CLEAR THAT I AM NOT HERE REPRESENTING ANY OF THE GROUPS THAT I HAVE MENTIONED, BUT I AM HERE AT THE INVITATION OF YOUR CHAIRMAN, CONGRESSMAN DOUG WALGREN.

IT APPEARS THAT THE DECIMATION OF THE GOVERNMENTS COMMITMENT TO, AND INVOLVEMENT IN FIRE SAFETY, FIRE CONTROL AND FIRE RESEARCH, IS DESTINED TO CONTINUE UNTIL IT NO LONGER EXISTS. AT THE RATE IT IS OCCURRING WITH THIS ADMINISTRATION, ITS DEMISE APPEARS IMMINENT.

I WISH TO SPEAK SPECIFICALLY TO THE CENTER FOR FIRE RESEARCH. IN MY OPINION, THE CENTER FOR FIRE RESEARCH IS TO THE NATIONAL FIRE PROBLEM WHAT JOHN HOPKINS UNIVERSITY WAS, FOR DECADES, TO THE MEDICAL FIELD - - - WITH ONE LARGE DIFFERENCE - - THE CENTER AND ITS PERFORMANCE ARE NOT SO WELL KNOWN, NOR IS IT SO WELL FUNDED, STAFFED AND EQUIPPED.

OUR COUNTRY EXPERIENCES THE GREATEST DESTRUCTION BY FIRE, IN FIRE DEATHS, PERSONS INJURED AND MAIMED, AND PROPERTY DESTROYED, OF ANY COUNTRY IN THE WORLD.

WE HAVE DEVELOPED THE GREATEST FIRE SUPPRESSION FORCES AND EQUIPMENT THAT MONEY AND THE STATE OF THE ART CAN PROVIDE, YET WE KNOW SO LITTLE ABOUT THIS ENERGY RESOURCE AND MENACE. HOW CAN WE BE SO UNREALISTIC AS TO SPEND BILLIONS OF DOLLARS TO MATCH STRIKE CAPABILITY WITH NUCLEAR WEAPONS, YET PERMIT THE DEVESTMENT OF OUR NATIONAL RESEARCH EFFORT FOR FIRE? CAN WE CONSCIOUSLY LET OURSELVES BECOME THE ONLY MAJOR CIVILIZED NATION WITHOUT SUCH AN EFFORT. SURELY, AN UNDERSTANDING OF DEFENSE FROM THE EFFECTS OF FIRE MAY WELL BE A FACTOR VITAL TO OUR SURVIVING MODERN WARFARE, ESPECIALLY OF THE NUCLEAR VARIETY.

I ASKED JACK SNELL, DIRECTOR OF THE CENTER FOR FIRE RESEARCH, TO SUMMARIZE THE EFFECT TO RESEARCH ALONE, IF THE CENTER WERE ABANDONED. HE SAID "GRANTS TOTALING $2 MILLION PER YEAR TO 30 LEADING UNIVERSITIES AND NON-PROFIT LABORATORIES WOULD BE HALTED, TERMINATING OUR PROGRESS IN DEVELOPING SCIENTIFIC KNOWLEDGE OF BASIC FIRE PHENOMENA SUCH AS IGNITION, FLAME SPREAD, SMOLDERING, RADIATION, SOOT FORMATION, ETC. ALL OF THESE ARE NECESSARY TO SAFER MATERIALS AND DESIGNS. SUCH INSTITUTIONS AS CAL-TECH, PRINCETON, FACTORY MUTUAL, NOTRE DAME, HARVARD, AND THE UNIVERSITY OF CALIFORNIA - BERKELEY PARTICIPATE IN THESE RESEARCH EFFORTS.

TOXICITY OF FIRE GASES HAS A DIABOLICAL EFFECT ON THE ENVIRONMENT, AS WELL AS ITS OCCUPANTS, POPULATION AND FIREFIGHTERS. FIREFIGHTING EFFORTS IN HIGH RISE STRUCTURES ARE PROBABLY LIMITED MORE BY THE BEHAVIOR OF TOXIC GASES, AND THE SHORT TERM USEFULNESS OF ~~LOCATING~~ Breathing APPARATUS, THAN ANY OTHER FACTORS. WE NEED TO KNOW MORE ABOUT THEM. WHO IS TO SAY WHERE THE RESPONSIBILITY LIES? IS IT WITH INDUSTRY OR GOVERNMENT? IS IT THE PRIVATE OR PUBLIC SECTOR? WHO WILL DEVELOP AND MAINTAIN APPROPRIATE AWARENESS?

WHILE CHIEF OF THE CHARLOTTE FIRE DEPARTMENT, I RECEIVED A LETTER FROM THE WHITE HOUSE DATED JUNE 1, 1982, FROM WHICH I QUOTE EXCERPTS FOR BREVITY "I COMMEND YOU AND YOUR ORGANIZATION FOR YOUR CONTRIBUTION TO THE DEVELOPMENT OF AN INNOVATIVE QUICK REACTION SPRINKLER HEAD.---------FIRE LOSS IS OF GREAT CONCERN TO THIS NATION.

—— THIS PROJECT IS AN OUTSTANDING EXAMPLE OF WHAT GOVERNMENT AND PRIVATE INDUSTRY CAN ACHIEVE WHEN WORKING TOGETHER TO SOLVE A CRITICAL NATIONAL PROBLEM." SIGNED BY PRESIDENT REAGAN.

CERTAINLY, FIRE, WITH ITS PRODUCTIVITY AND ITS CONSEQUENCES, CANNOT BE LEFT UNATTENDED, IGNORED BY THE FEDERAL GOVERNMENT, AND ATTENDED TO BY THOSE WHO ARE MOTIVATED, OR SATISFIED BY PROFIT.

THOUGH IT IS NOT WIDELY KNOWN, AND I AM ON RECORD WITH THE EVALUATION PANEL AND THE CENTER FOR FIRE RESEARCH, FOR INCREASING ITS VISIBILITY, THE LAST SEVERAL YEARS HAVE BROUGHT ABOUT A COORDINATED EFFORT BETWEEN INDUSTRY, INSTITUTIONS AND THE U. S. GOVERNMENT. TOGETHER THEY HAVE ADDRESSED THE PROBLEMS ASSOCIATED WITH THE PHENOMENON OF COMBUSTION IN ALL OF ITS FORMS. THE EFFECTS, BENEFICIAL AND ADVERSE, ARE BEING RESEARCHED, STUDIED AND ANALYZED. THE FIRE SERVICE, IN THE BROAD SENSE, DOES NOT KNOW OF THE CENTER FOR FIRE RESEARCH'S ROLE AND INVOLVEMENT. I SUGGEST IT IS NOT WIDELY KNOWN IN ACADEMIA. CERTAINLY INDUSTRY HAS LITTLE KNOWLEDGE OF IT. I SAY TO YOU, AS I HAVE SAID TO THOSE AT THE CENTER AND THE EVALUATION PANEL, WE NEED TO MAKE THESE EFFORTS MORE WIDELY KNOWN.

HOW WE HAVE MAINTAINED SUCH COMPETENT, HIGHLY QUALIFIED, DEDICATED STAFF, I DON'T KNOW. FOR THE PAST SEVERAL YEARS STAFF HAS BEEN FACED WITH DIMINISHED RESOURCES AND PERSONNEL AND, IN FACT, COMMITTED TO SURVIVAL TACTICS WHEN THEY SHOULD HAVE BEEN SOLVING PROBLEMS PERILOUS IN NATURE TO THE ENTIRE NATION.

IT HAS TAKEN YEARS OF EFFORT ON THE PART OF MANY, IN AND OUT OF THE BUREAU, TO PUT TOGETHER THE BRILLIANCE THAT IS FOUND IN THE RESEARCH AND MANAGEMENT TEAM AT THE CENTER. LORD KNOWS THEY ARE NOT ATTRACTED BY THE PAY. BUT THEY ARE THERE. IF CONGRESS ALLOWS THIS CENTER TO BE WIPED OUT, GENTLEMEN, I ASSURE YOU SUCH A TEAM WILL NOT BE REASSEMBLED IN YOUR LIFE TIME. FURTHER, IF SOME SENSE OF PERMANENCE OR SECURITY FOR THE CENTER CAN BE ARRIVED AT, IT WILL ENHANCE OUR CHANCES, IN THE FUTURE, OF ATTRACTING HIGHLY, QUALIFIED SCIENTISTS TO THESE TASKS AND OPPORTUNITIES.

I HAVE BARELY SCRATCHED THE SURFACE, BUT I WAS ASKED TO LIMIT MY REMARKS TO 5 MINUTES. I WILL BE PLEASED TO RESPOND TO QUESTIONS. THANK YOU FOR YOUR ATTENTION.

Mr. **Walgren**. Thank you very much for those views, Chief Lee. They are certainly well stated and from the best authority.

Professor Bryan.

[The biographical sketch of Dr. Bryan follows:]

Biographical Sketch

DR. JOHN L. BRYAN

Professor and Chairman, Department of Fire Protection Engineering,
University of Maryland

Born in Washington, D.C.; Resident of Montgomery County, Maryland

Education: BS, Oklahoma State University, 1953 - Industrial Education
MS, Oklahoma State University, 1954 - Industrial Psychology
EdD, American University, 1965 - Educational Psychology

Experience:

Twenty-seven years of paid and volunteer fire department experience. Field investigation and training with Grain Dealers Mutual Insurance of Indianapolis and with the University of Maryland Fire Service Extension Department.

Professional consulting with such organizations as Flynn and Emrich of Baltimore, U.S. Coast Guard, American Iron and Steel Institute, Chesapeake and Potomac Telephone, National Education Association, Owens Yacht Corporation, City of Sidney, Ohio, Alcoa, Reynolds Electric and Engineering, NASA, and De Leuw Cather, Inc.

Educational consulting with the Institute of Government, University of North Carolina; Rowan Technical Institute; State Education Department, New Hampshire; Ohio State University; NASA; and American Iron and Steel Institute.

Professional Organizations:

Associate Member - National Fire Protection Association
Member - Society of Fire Protection Engineers
Member - American Society for Engineering Education
Member - Committee E-5, Fire Tests, American Society for Testing and Materials
Member - American Association of University Professors
Member - Trustees, Underwriters' Laboratories, Inc.

STATEMENT OF PROF. JOHN L. BRYAN, CHAIRMAN, DEPARTMENT OF FIRE PROTECTION ENGINEERING, UNIVERSITY OF MARYLAND

Dr. **Bryan**. Thank you, Mr. Chairman. I appreciate the invitation to appear at this hearing before the committee. I have a written statement which I understand will be put in the record. I would just like to summarize and make a few statements to emphasize some points in there and maybe to expand on a few areas. I would want to emphasize that my statement is in opposition, as the title says, to the deletion of funding for the Center for Fire Research.

These are my own opinions. They are based on 29 years of association with the research efforts at the Center, long before it was known as the Center for Fire Research. In 1967, the last time I appeared before this subcommittee, it was on the very concept of setting up a commission, which Professor Bland later headed, to study the fire problem. At that time I reflected on what I felt was the value of the research efforts at the center, and I would have to say at this time, my understanding of those has increased more than 500 percent due to the development of the Center under the able leadership of Dr. Lyons before he moved to the National Engineering Laboratory.

I want to mention on what Jack touched on; the people there. Something that has not been mentioned yet verbally, although it may be in other written statements, the international cooperation involved in by the Center with European countries, particularly Japan and with the Russians. In all of these areas the Center for Fire Research has been the contact so that the American fire protection community has benefited by research efforts in these other countries. Many times the type of research due to cultural, social, political factors cannot be conducted in this country and we have benefited from it. They have people who are recognized internationally in the area of smoke detectors; in the area of toxicity; in the area of fire modeling, which I believe holds the greatest future for the development of fire-safe buildings in this country. There's a personal and a people aspect to the center which if it is allowed to dissipate, I would agree with Jack, it would never be reassembled, I would say in this century.

The second area I would like to make a few comments on involves an area which Professor Bland mentioned slightly: social science research. I have been involved in the human behavior research on the actions and behavior of people in fire incidents and in buildings during a fire incident. All of which has been funded by the Center for Fire Research. The Center for Fire Research is the only local, State, or national agency that has had a continuing program in this important area. Without the Center, the program will, the effort will dissipate. It's been conducted by a number of universities, not just the University of Maryland. The University of California at Berkeley has been involved with the School of Architecture. The University of Washington psychology department. University of North Carolina at Chapel Hill. There have been a number of these programs, Loyola University in Chicago, and all of these efforts have been from funds from the Center for Fire Research. I want to emphasize that their program has involved agencies which had people with specialized interests and capabilities to assist in this work, and it's had a twofold effect. The research money they grant has, of course, developed people in these institutions that are now very active in these areas with graduate students and undergraduate students on their own. But if you lose that Federal effort, direction, coordination, and money, that research, of course, dwindles. So I would like to emphasize that research personnel aspect.

In conclusion I would like to repeat my final sentence that the Center for Fire Research must be funded because there's no valid alternative in the United States and I might even say, maybe, in the world. Thank you.

[The prepared statement by Dr. Bryan follows:]

STATEMENT IN OPPOSITION TO THE FY84 PROPOSED ELIMINATION OF THE FUNDING FOR THE CENTER FOR FIRE RESEARCH OF THE NATIONAL BUREAU OF STANDARDS

By

Dr. John L. Bryan

STATEMENT PRESENTED TO THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY OF THE U.S. HOUSE OF REPRESENTATIVES

March 16, 1983

I. REPRESENTATION

It should be clearly understood, the views, opinions and concepts presented in this statement represent only the philosophy of the individual and should not be implied to represent the Department of Fire Protection Engineering, the University of Maryland, or the State of Maryland in any manner. In addition it should be recognized, the statements in this presentation should not be attributed to reflect either directly or indirectly on the professional organizations I am currently involved in, or have been a member of previously. This presentation is intended to represent only my personal and professional philosophy.

II. RELATIONSHIP WITH THE CENTER FOR FIRE RESEARCH

I wish to emphasize at this time, I personally, and the Department of Fire Protection Engineering at the University of Maryland, currently have no research contracts or financial agreements with the Center for Fire Research, although we have had such grants in the past. It should be noted, however we utilize Center personnel as adjunct faculty, there are university faculty that consult at the Center and the Center participates in the cooperative education program of the Department.

My relationship with the Center for Fire Research predates the current terminology for the Center and has existed since 1954, a period of twenty-nine years. This professional contact was initiated when the fire research activities of the National Bureau of Standards were conducted in modified buildings at Connecticut Avenue and Van Ness Sts. in the District of Columbia. Thus, I have observed over a period of time the balance the fire research program at the National Bureau of Standards has maintained between basic, theoretical fire research and the empirical applied aspects of their fire research efforts.

It would appear, the Center for Fire Research at the present time is more effective and productive as an organization, than I have observed over the twenty-nine year period. The staff is a combination of uniquely qualified scientisits, engineers and technicians who are highly motivated and sincerely committed to the alleviation of the fire problem in the United States. It should be recognized that personnel at the Center for Fire Research are recognized as some of the outstanding authorities in not only the United States but in the World in specific areas of fire research. I must mention the outstanding high quality and world renowned studies that have been conducted in the fire research areas involved with the toxicity test procedure, the evaluation and development of test procedures for smoke detectors, and the development of field test procedures for smoke control and smoke removal systems.

In addition, in relation to the evaluation of materials utilized in the construction of buildings, the interior finish within the buildings, and the furnishings within buildings, the Center for Fire Research has an enviable record of research culminating in the development of test methods and procedures. These test methods are invaluable to the fire marshals and the building officials in every jurisdiction and governmental unit in the United States from the smallest village to the largest urban city. It must be realized most of these authorities utilize these test methods as they are referenced in one of the three regional Building Codes (4)(11)(10), or the Life Safety Code (14) and do not realize these test procedures were developed at the Center for Fire Research. The most critical of these test methods I wish to remind you of consist of the following: ASTM E-162, Radiant Panel, (1); ASTM E-662, Smoke Chamber, (2); and the ASTM E-648, Radiant Panel Flooring Test Method, (3).

It should also be recognized the current test procedures utilized by the Consumer Product Safety Commission in their evaluation of flammable fabrics and mattresses are test procedures originally developed by the Center for Fire Research. Thus, it would appear there is no other similar organization in local or state government, including private agencies that currently have the personnel, the facilities or the unbiased attitudes and approaches to research and develop the needed fire test procedures for the evaluation of materials as utilized in buildings. In this regard the critical parameter is the possession of the unbiased attitude and approach.

The research efforts of the Center for Fire Research are not usually recognized as contributions to the fire protection of local communities and governmental units in the United States, since these research results are utilized in the building codes as previously mentioned, and are also referenced in the provisions of the National Fire Protection Association standards (15). The fire modeling research program at the Center for Fire Research would appear to offer the most potential benefit in the understanding of the fire propagation process, and offers promise of startling improvements in the fire protection design for future structures.

It would appear of all the agencies recognized and created in the Federal Fire Prevention and Control Act, the Center for Fire Research has been the most effective and productive.

III. HUMAN BEHAVIOR STUDIES

The Center for Fire Research is the only federal Government agency that has initiated and maintained a comprehensive and continued research program into the problems related to the behavior and experiences of individuals within buildings at the time of a fire incident. The Center funded studies which have established a basis for the understanding of the parameters of this problem from approximately 1970 until 1982, with the following institutions: Loyola University, Chicago; University of California, Berkely; University of Washington, Seattle; University of North Carolina, Chapel Hill, and University of Maryland, College Park.

A. University of Maryland Programs

Due to my professional involvement with the University of Maryland, Center for Fire Research grant funded Project People (5) and Project People II (6) studies, I would like to review the outcomes and the results of these research grants from 1974 to 1982 (7).

The Project People I study involved the questionnaire responses of 584 individuals involved in 335 fire incidents, primarily involving residential occupancies in the Washington, D.C. and Baltimore, Maryland metropolitan areas. The individual participants were interviewed by fire department personnel, at the scene of the fire incident. As a result of this study the following conclusions appeared to be the most significant results.

1. Individuals would engage in reentry behavior in residential occupancies.
2. Participants engaged in fire fighting behavior in the residential occupancies, with little distinction between male and female participants, with an age range from eight to over eighty years of age.
3. Most individuals were alerted to the fire incident by other individuals within the living unit.
4. Participants would move through smoke, distances beyond their visual observations if they believed they were moving toward a means of egress or escape.

The Project People II study was a companion study, developed from the Project People I research experience. This study involved tape recorded interviews of the participants and responding fire department personnel by the University of Maryland research staff in an open ended manner, followed by the application of a revised Project People I questionnaire. The research staff studied the construction features of the building involved with the areas of fire and smoke propagation to be able to determine the realms of fire development. The realms were then matched with the episodes of the behavior of the participants utilizing the technique developed by Lerup at the University of California, under a grant from the Center for Fire Research (13). This technique enabled the mapping of the realms and the episodes in conjunction with a temporal pattern of the fire incident. This mapping procedure enabled the study of the interrelationship between the physical fire threat conditions and the behaviorial activities of the participants. The research study consisted of a total of 59 fire incidents in health care facilities, and eight fire incidents in residential, correctional, and educational occupancies which involved the evacuation of more than 200 participants in each incident. A total of 848 participants, and 79 fire department personnel, submitted questionnaires or were interviewed in relation to these 67 fire incidents. The following conclusions from this study appeared to be the most significant:

1. The dominance of the professional role in the initiation of the behavioral activity of the staff personnel in the fire incidents in the health care occupancies.

2. The recall of the established and trained procedures for a fire incident by personnel in the health care occupancies.

3. The participants in large structures during a fire incident are involved in an information processing situation, and they need valid, reliable information from the fire department.

4. The recognition and documentation of the formation and occurrence of "Convergence Clusters" in large residential occupancies during a fire incident (8). These convergence clusters were also documented in the

more recent study of the human behavior in the MGM Grand Hotel fire (9) partially funded by the Center for Fire Research under their cooperative agreement with the National Fire Protection Association and the U.S. Fire Administration.

The Project People II study utilized the Fire Safety Evaluation Survey (16) developed by the Center for Fire Research as a means to identify the comparative fire safety of the facilities within the health care occupancies.

It should be recognized in all of the human behavior studies conducted by the Department of Fire Protection Engineering at the University of Maryland, since 1956, involving 405 fire incidents varying from a single family dwelling to the MGM Grand Hotel, there has only been one observed documented fire incident which involved panic behavior. However, we are considering "Panic" as classically defined, consisting of flight behavior resulting in injuries to oneself or others, as a result of the flight behavior (10). The most characteristic and most often observed behavior on the part of the occupants involves altrusitic behavior in contrast to nonadaptive or "Panic" behavior. The occurrence and formation of the "convergence clusters" is symbolic of altrusitic behavior in the sharing of the area of refuge with others. Thus, from my limited professional experience in this area I must agree with Jack Keating at the University of Washington, in relation to the "Myth of Panic" (12). It appears "Panic" and I prefer the term, "nonadaptive behavior" is a very unique occurrence in the behavior of individuals in fire incident situations.

IV. SUMMARY

The Center for Fire Research of the National Bureau of Standards, is a valuable, effective and productive organization involved in fire research essential to the well being and safety of every citizen. The research output of the Center is most important and critical to the codes and standards utilized in every community to establish a basis of fire safety for their citizens. The Center for Fire Research contains dedicated, recognized professional personnel that provide a highly dedicated and motivated research agency that is a focus for the fire research in both the United States and the World. The Center for Fire Research MUST BE RETAINED since there is no valid ALTERNATIVE OR REPLACEMENT, and without the RESEARCH FOCUS AND EFFORT OF THE CENTER, fire protection, and every community in the United States will be the eventual Losers.

A SELECTED BIBLIOGRAPHY

1. American Society for Testing and Materials, Standard Test Method for Surface Flammability of Materials Using A Radiant Heat Energy Source. Philadelphia: American Society for Testing and Materials, E-162, 1981.

2. American Society for Testing and Materials, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials. Philadelphia: American Society for Testing and Materials, E-662, 1979.

3. American Society for Testing and Materials, Standard Test Method for Critical Radiant Flux of Floor-covering Systems Using a Radiant Heat Energy Source. Philadelphia: American Society for Testing and Materials, E-648, 1978.

4. Building Officials and Code Administrators, International, Inc., The BOCA Basic Building Code. Homewood, IL: Building Officials and Code Administrators, 1981.

5. Bryan, John L., Smoke as a Determinant of Human Behavior in Fire Situations, (Project People), Washington, D.C.: Center for Fire Research, National Bureau of Standards, Department of Commerce, NBS-GCR-77-94, June 30, 1977.

6. Bryan, John L. and James A. Milke, The Determination of Behavior Response Patterns in Fire Situations, Project People II Final Report-Health Care. Washington, D.C.: Center for Fire Research, National Bureau of Standards, Department of Commerce, NBS-GCR-81-343, September, 1981.

7. Bryan, John L., *Implications for Codes and Behavior Models from the Analysis of Behavior Response Patterns in Fire Situations as Selected from the Project People and Project People II Study Program*. College Park: Department of Fire Protection Engineering, University of Maryland, 1982.

8. Bryan, John L. and Philip J. DiNenno, *An Examination and Analysis of the Dynamics of the Human Behavior in the Fire Incident at the Georgian Towers on January 9, 1979.* Washington, D.C.: Center for Fire Research, National Bureau of Standards, Department of Commerce, NBS-GCR-79-187, April 30, 1979.

9. Bryan, John L, *An Examination and Analysis of the Dynamics of the Human Behavior in the MGM Grand Hotel Fire*, Quincy: National Fire Protection Association, April, 1982.

10. Bryan, John L., *A Study of the Survivor's Reports on the Panic in the Fire at the Arundel Park Hall, Brooklyn, Maryland on January 29, 1956*. College Park: Department of Fire Protection Engineering, University of Maryland, 1957.

11. International Conference of Building Officials, *Uniform Building Code*. Whittier, CA.: International Conference of Building Officials, 1982.

12. Keating, John P., "The Myth of Panic," *Fire Journal*, LXXVI, 3, (May, 1982), 57-58, 60-61, 147.

13. Lerup, Lars, *People in Fires: A Manual for Mapping*. Washington, D.C.: Center for Fire Research, National Bureau of Standards, Department of Commerce, NBS-GCR-77-106, 1977.

14. National Fire Protection Association, *Code for Safety to Life From Fire in Buildings and Structures*. Quincy: National Fire Protection Association, 101, 1981.

15. National Fire Protection Association, *National Fire Codes, Volumes 1-16*. Quincy: National Fire Protection Association, 1983.

16. Nelson, H.E. and A.J. Shibe, *A System for Fire Safety Evaluation of Health Care Facilities*. Washington, D.C.: Center for Fire Research, National Bureau of Standards, Department of Commerce, NBSIR 78-155, November, 1978.

17. Southern Building Code Congress International, *Standard Building Code*. Birmingham: Southern Building Code Congress, 1979.

Mr. **Walgren**. Thank you, Professor Bryan.

That is clear and direct and certainly unequivocal testimony in support of the Center for Fire Research. I think the fact of that will be quite significant when the committee sits down to evaluate the course which we feel is best for the country to go forward with.

I notice, Professor Bryan, you indicate in your testimony that you have been involved in some of the behavior studies. One of our problems with the Federal Government, for example the National Science Foundation, is we haven't been able to get them to give the proper emphasis to behavior studies. It seems we have a lot of appetite for the material—assembly of physical matter and the study of physical matter—in this country but very little appetite to study people's behavior. You indicate in there that there's very little panic in fires, and really a rather altruistic and I gather somewhat controlled response of people who actually find themselves confronted with fire. Is that a proper characterization? I'd be interested in what you have sensed.

Dr. **Bryan**. From our studies I would say yes. I'm not sure what you mean by the terminology, "controlled." Don't get the idea these people are not very anxious. Many times they are very emotionally concerned because their lives are threatened; they recognize that and as I indicated, they need information relative to the degree of the threat; the length of time they will be threatened. But when you examine the behavior they do not behave in a competitive aggressive manner toward each other. Instead it's an assisting, helping, the "convergence clusters" I mentioned are very symbolic examples of that. That is where you have people assisting people to the best areas of refuge. In the MGM Grand Hotel fire these were rooms that had balconies; these were rooms on the sides of the hotel that were not exposed to the exterior smoke exposure. You have this sort of assistance between the individuals. This does not mean they are not concerned and anxious. But their behavior is not the characteristic competitive behavior which involves injury to themselves or others. We just haven't seen that.

My original study in 1956 is the only study I've documented that in. This was a little different situation in that the stimulus for the action of the individuals—the initial stimulus were so ambiguous they were ignored. When it became apparent there was a fire there was not time for cooperative action and it did degenerate into a competitive situation with many injuries to the people in the audience. But since 1956 that is the only incident in which I have been able to document panic. I have to agree with Jack Keating from the University of Washington, that panic is, from our studies, it's a very unique, very specialized event. It's not the common event that the media might lead you to believe.

Mr. **Walgren**. But this indicates, just from first blush, perhaps, a real area of opportunity. If people's actual behavior, when confronted with that kind of threat, is something other than real panic, then it would seem that there would be great potential if we could structure it properly and manage that behavior properly to have a much better outcome.

Dr. **Bryan**. Generally, if I could characterize it, initially it's investigative and information seeking. The initial cues are usually so ambiguous. They are trying to structure those cues with more information about the threat. Where is the fire located? The fire was below the 5th floor in the MGM and due to the heat people thought it was on their floor or on the 18th through the 25th floors. They were seeking information. They felt the door—when you feel heat you assume the fire is on your floor. So, initially it's information seeking and then it's very rational decision making. "Can I get out or do I stay here?" In that respect you have people turning on TV to get information; they do not get it, they turn on the radio. They try to call—some of them even called the fire department when they couldn't reach the desk. So the behavior of the people is very rational. Some of them utilized cues from public education programs to help them.

Mr. WALGREN: Chief Lee, you mention in your testimony the frustration that the value of the Center for Fire Research—its work is not more widely known. It's also frustrating, I know for many members of Congress, to be able to get a handle on the value of transfer of information because you can't put your finger on it. It involves effort that costs money and yet there's nothing that you can concretely put your finger on like bricks and mortar to justify the tax payers expenditure. It often involves people and time, more than anything else and it's so difficult to have confidence that the people are really using their time to the best effectiveness and value as opposed to an effort where people are together and nothing really happens.

I'd like to ask about your frustration in seeing the Center for Fire Research better understood in the private sector and in the interested fire community across the country. What would you try to tell them if you had the opportunity to tell them and can you give us some indication of why something of value is not better understood.

Mr. LEE. We heard it said here this morning that firefighters are using essentially the same equipment that they were using 50 years ago. There have been changes. They're using fire resistant materials to develop this clothing out of that we didn't have during these times. We've had specific studies of the fire protection envelope through the Center for Fire Research and others, to reach the circumstance where we are dressing our people as safely today as the state of the art and the economy will allow. I have been apprised since I arrived, by Dr. Jack Snell, that in the last ED3 courses—Executive Development 3 courses—that have taken place out at the Academy, he has made it a point to address those folks, those young and older executive level fire officers, as they go through their training to the programs at the Center for Fire Research. I didn't have time for him to tell me exactly what his communication efforts contained. But they are addressing the problem that I alluded to and that is, that we the fire service, in general think that nothing is going on at the National level, through some specific efforts to make the lot of the firefighter more tenable. It is taking place, the communications effort is now taking place. How Dr. Snell is going to address this with industry and with the academic, I am not sure. But I am heartened by the efforts that were reported to me this morning. I feel that as a result of the identification of this problem that it will occur.

Mr. **Walgren**. I wanted to ask, Professor Bland, you mentioned that much of the upshot of our effort has resulted in parochial limitations and parochial efforts. Could you expand on that for us to try to let us know a little bit more about the disappointment of someone, such as yourself, who saw the direction first given by the National Commission on Fire Prevention and Control and then the 10 years of implementation.

Prof. **Bland**. By parochial I mean the program is now nearly totally directed toward the fire suppression forces. Putting the firefighter in improved protective clothing, Giving him lighter breathing apparatus, automating the mobile fire equipment, improving communication, will not significantly reduce the fire loss in the United States. The Fire Academy is focusing on the firefighter, that is parochial. The American firefighter, on an hour-by-hour basis, demonstrates his capability in fire suppression. Mobile fire suppression forces are not the problem.

The academy become, parochial when it reports on the number of firefighters that it trains. I am saying that the problem must be approached by the total technological community. That includes architects, builders, designers along with the fire suppression forces. There does not seem to be an academy program aimed for those professions. For instance, I recently attended a National Academy of Sciences meeting where architects and engineers studied the fire problem in the context of energy conservation. Energy conservation and fire prevention can act counter to each other. In one instance you are trying to encase everybody and conserve heat while under fire conditions we must be able to quickly open the enclosure to let heat out. I'm not against the U.S. Fire Academy and if this comes out that I'm against training the firefighter, that is not my intent. Training is very important. In Pennsylvania, Mr. Chairman, there are approximately 2,700 fire departments. They are everything from four men and a 1925 engine to big places like Philadelphia's and Pittsburgh's. Communicating is extremely difficult; we talk about outreach it is a great concept. But, as an example, in the Commonwealth of Pennsylvania, each year the number of firefighters entering and leaving the service, volunteer and paid, is about the same size group that enters into the Junior high schools. We're talking a large turnover every year not only in Pennsylvania, but in the total United States. The U.S. Fire Academy at Emmitsburg cannot be expected to impact that size group. Even to train the trainers is a massive undertaking. The delivery of basic training to the tailboard is a firstly order objective, but it should not be considered as a responsibility at the Federal level.

An interesting question was raised, as to paid, versus volunteer firefighters attending the academy. Paid departments have manpower pools, management challenges and career ladders where course attendance is a recognized route for advancement. Those same paid departments exist in urban areas where community colleges and universities exist for the purposes of higher education. The volunteer generally has no such incentives.

Chief Lee's concern for communicating to the fire suppression services—the work being done at the center for fire research—points up a learning problem. Let me use an example. We were funded by USFA at Penn State to conduct a junior/senior credit course for firefighers. We agreed to one time experimental correspondence courses. Fire administration was one title, Analytical Approaches to Fire Protection was the other. There were 30 students in each group. They were from all over the northeastern United States. For the junior and senior college level, the courses were not difficult. Of the 60 students, 13 finished the four assignments.

Almost concurrent with that I was called by the U.S. District Court in the York to testify on behalf of the International Association of Firefighters who were, defending an FDNY entry requirement of a high school education. The court decided, that a high school education was not not necessary for entry as a firefighter.

We are faced with a tremendous range of intelligence and capability in the American fire suppression services. An academy function must be translation as well as information transfer.

I am concerned about the Academy getting into the teaching business. Now back to a critical issue before this hearing. If you do any with the Center for Fire Research and its generation of knowledge; if you do away with the data system; and you keep the academy, what knowledge does the academy transfer. There's nothing new this week. It's Chief Lee and I getting together and telling war stories.

Mr. WALGREN. Thank you, Professor Bland.

Mr. Brown.

Mr. BROWN. Professor Bland, you conclude your written statement with a line about enhancing the U.S. Fire Administration's role so that it can mature and function with recognized authority as the Federal agency cooperating in destructive fire loss management.

I think that this is something that the subcommittee would like to do and I want to know how to do it. I've just looked at the act again, and I'm impressed with how well the act is written, although it's 10 years old. It's a tribute to the Commission and the studies that went into the conceptualizing what was needed. It has all of the areas spelled out in it. The need for technology; the National Fire Data Center; the rural assistance; the public education; all of the things are listed there. Many of which have not been carried out in practice. We still haven't moved to the stage of having the well-rounded properly prioritized kind of activity that I think you probably wanted, and Chief Lee and Professor Bryan were all contemplating when you participated in the development of this program.

Is there some way—we don't want to rewrite the act. I'm not sure that we could do it any better. We can in the record of this hearing and in the report of this subcommittee renew our commitment to the goals set forth here and the mechanisms. Is there any other way that we can give the emphasis that you are asking us to on the importance of the U.S. Fire Administration as the integrating force? With the responsibility to make sure that we have a national program that meets our needs as effectively as possible. Double the appropriation maybe?

Prof. BLAND. No. I have been very careful, Mr. Brown, not to talk about additional appropriations.

Mr. BROWN. That's the easy way out.

Prof. **Bland**. We could probably do a lot better if we could objectively get the act together within the existing appropriation. Try that first; if justification is then found for additional appropriations then they should be considered.

We may progressively, over the 10 years, done ourselves in. I was concerned when, in the Presidential reorganization, we moved the Fire Administration into FEMA. A fire is an emergency and first thoughts seemed to lead to FEMA. But the time scale of an earthquake or the time scale of the Johnstown Flood, is altogether different than the time scale of a fire. Two minutes of fire and everything in the room was consumed.

When we put the USFA into FEMA, we lost visibility and we forced fire into a time scale that is foreign to the historical FEMA mission.

But, no administration, from Nixon, Ford, or Carter administration, through the Reagan administration has really supported this public safety program. There is something inherent here that White House people don't like. It is beyond me. We've had an uphill fight every foot of the way.

I agree with Chief Lee, we may have lost this in an effort to establish a Federal focus for distructive fire.

Mr. **Brown**. We're going to have to rethink this situation. It may well be that there's an institutional disease here that is at work that has prevented this maturation process that we had hoped would occur.

There are problems in having this located and subordinated in an agency like FEMA although on the surface it appears to be the natural agency. It involves itself with the other emergencies that you mentioned. You name it and there's a FEMA program in response. But each of these differs from the fire emergency in the way that you have indicated, the time scale. There's another aspect. The very continuity of the fire problem. There's a fire every minute, probably, around this country, and we need a continuing, high-level attention to both the rapidity of the individual event and the pervasiveness of the totality of these events.

What I would like to see is a Federal Emergency Fire Management Agency, and then subordinate these others to it.

It would be quite logical because of the central role of the fire service, and in my opinion we would do a better job of preparing for some of the other disasters. You referred to the nuclear disaster. I don't know a thing about the possibility of a nuclear disaster that would lead me to think that a comprehensive emergency response built around the continuing needs of fire couldn't handle better than what we are doing now.

There are political and psychological reasons why FEMA has been built around that specific thing rather than the more ongoing continuous and costly problems that are centered in the fire problem.

Prof. **Bland**. It's a very difficult area, Mr. Brown.

One of the things that intrigues me about the fire problem is that you can approach it in the context of a federalist system. Effective fire protection is any example of cooperation at all levels of governments. It's right at the core of the whole Federal concept. It's interesting that each administration over the years has taken the position of being more federalist than previous administrations, yet, a program like fire protection that depends upon cooperation and the sharing of responsibilities based on capability and capacity and need, takes a such a licking. That's an inconsistency I have when I think of government.

State College, Pa., my hometown, obviously could not run a center for fire Research. We would not want it to do that and we would not want that data proprietary to State College, Pa., and neither would we want it proprietary to the State of Pennsylvania. CFR has a capacity and a capability of people and machines existent at the Federal level that is in service to the public. Basic research should not be done, cannot effectively and efficiently be done with equity at the local and State levels. That's why the Federal Government must do it.

Mr. **Brown**. I see nothing inconsistent with the strong Federal role that you are describing here. And with the President's own commitment to a decreased Federal budget or a decreased Federal role in general—because in the letter you quoted, Chief Lee, he points out the importance of the cooperative relationship between government and private industry, and he should have added local government as well as Federal Government here. The key to our successful meeting of problems throughout our society today is building these cooperative structures with a proper relationship between the partners instead of an overemphasized relationship on the Federal or the private or any other particular segment. Finding balance is sometimes the most difficult problem in physics, as well as in government, we haven't seemed to set up the proper framework for that proper balance.

If you have any further suggestions as to how we could improve upon what's already set forth in the act or give emphasis to it or renew it in some meaningful way I know that the subcommittee would like to have it because that's exactly what we would like to accomplish.

Prof. **Bland**. The point you made, Mr. Brown, is very valid. The commission saw the problem and handled it in mature fashion within the time and confines of the money, incidently, one of your colleagues once said it's the only commission that ever finished its job within the time that was allocated and with the money that was appropriated to it.

I think the Congress put the act together well. I would just like to go back to the act and start from there. Forget the last decade and see if we can recoup and get an effective maturing program on the way that demonstrates Federal responsibility in a very vital public safety issue.

The problem has its parallels in crime; it's a public safety issue. A police officer enforces the criminal code and motor vehicle Code. A fire officer, in the sense of code enforcement officer, enforces the Building Code and the Fire Safety Code. But in such contrast is the public's view of the police officer and the code enforcement officer. Both of them are public safety officers enforcing public safety codes.

In the fire situations there's always going to be risks. Our problem is assessing and minimizing those risks. It's never going to be an absolute thing. It's a perception of what is the risk and can I minimize it. We do not want to go back to a Flintstonian environment; I don't want to go back to the cave. I want to live with plastics. I want to live comfortably. I would like to do it with acceptable risk.

Mr. WALGREN. Mr. McGrath.

Mr. McGRATH. Thank you, Mr. Chairman.

I have a more than personal interest in fire and fire safety. My brother is a professional firefighter in the city of New York. My brother-in-law is a volunteer fireman on Long Island where I live, and I'm the honorary chief of three departments. I have a healthy interest in their safety. I'm a member of a volunteer company in my hometown. I don't get too many runs anymore——

I'm interested in one thing as a result of a tragic accident in my hometown. We had a Temple on fire on Thanksgiving night, a couple of years ago, seven of my colleagues in my company had a roof fall in on them, the result of a building violation code, perhaps. All seven ended up in a burn unit and two, thankfully, died in that burn unit, because they never would have been able to survive otherwise.

I'm interested in fire safety for the professional and volunteer men and research on ways of combating fire with new combustibles.

You spoke, Professor Bland, of plastics and maybe some types of toxic chemicals that we now are seeing in fires at plants. Who is responsible for that kind of research in order to disseminate information to professional and volunteer firemen so they can be better on guard for the types of things they come up against with new and modern fires?

Mr. LEE. I'll take a stab at your question.

The fire chief feels an awful lot of responsibility towards the safety of his people. As a result of the fire inspection and building inspection efforts that take place by all personnel, which leads us into the other aspect I think Professer Bland was getting into, fire departments are no longer fire suppression agencies. They are fire protection agencies with the responsibility of fire suppression, fire prevention, fire education, building code enforcement. Perhaps, as much as anything, it's a building code enforcement problem, I think you alluded to that, that helped to created this tragic circumstance.

The truth of the matter is there is no one agency that's responsible for all of those things that contributed.

Mr. McGRATH. Who might be responsible in this one specific instance. Is it the Fire Administration? Is there a research arm of the Fire Administration that does research into different combinations and permutations of toxic chemicals that can be demonstrated—what kind of fire comes out of this kind of combination of chemicals and whatever may be in the building that is on fire? How does a professional or a volunteer firefighter know what to expect and who is responsible for telling them what to expect out of a fire in a chemical warehouse.

Dr. BRYAN. I'll try and help you a little bit with your problem, Mr. McGrath.

You are going to hear from Jack Rhodes from Factory Mutual Research who has done work on the warehousing, manufacturing problem areas relative to flammable liquids. One example would be high-rack storage of aerosol cans and containers. They provide information and research reports. The Center for Fire Research, and we saw earlier a video tape of a room burnout, they provide information relative to primarily residential rooms: new materials like the material involved in the couch, the expanded plastic material. They put out research reports. The problem is the transmission and the transfer of this information to the firefighter. Like yourself, I'm a volunteer firefighter. This is really the role of the National Fire Academy, as Professor Bland indicated, as originally conceived as a communication means to provide this information to both the career and the volunteer firefighter. I would like to say that probably a lot of the responsibility belongs on the fire service itself. I think that's some of Professor Bland's frustration in the sense that we need better qualified individuals to understand the informations available from these people and provide it to their people in relation to what their officers and fire inspectors find out where these things are located in the community. It does no good to know that aerosol cans at a certain temperature will explode and injure people if you don't know you have them at XYZ company in your community.

Mr. McGrath. I understand.

Dr. Bryan. The research is done in two areas; residential by Center for Fire Research; industrial by Factory Mutual and I would have to include Underwriters Lab.

Mr. McGrath. I guess what I am trying to get out here is that the Center for Fire Research is being zeroed out of the budget. Am I correct?

Dr. Bryan. That's what is projected. We're trying to stop that.

Mr. McGrath. So am I.

Prof. Bland. I think that a part of the answer to your question, Mr. McGrath. Maybe John Lyons has to help me here, but toxicology may not be within the CFR charter. The organic charter of the Bureau of Standards may not allow it to do health research. As I understand it, CFR could not carry a dedicated research project on the indvidual or synergistic effects of toxic gases on human beings. They might be able to speculate on such effects but the research would have to be done in Department of Health or other appropriate agencies. I take that from when we were trying to develop the protocol at the Bureau of Standards in toxicity.

The answer to your problem is lacking because we have segregated agencies by discipline.

Mr. McGrath. I agree with you. That if we don't know where the problem is then it's worthless to have the information.

I think the professional and volunteer companies are well prepared to do that and to find out what is in what factory building in an area under their jurisdiction.

What I'm trying to find out, not the health of any one firefighter or one individual, what I'm trying to determine is the combustion itself. All of these toxic chemicals that are around today creating all that toxic waste out there—all that I'm trying to find out is whether there is anybody doing research to find out when you light a match to these chemicals, these plastics, what is the effect. How fast does it go? Then pass that information on to the local firefighters.

Maybe I shouldn't be asking you that question.

Mr. BLAND. No. I think it's a fair question. To my knowledge there are groups that are involved. I do not think the level to which they are supported is high. I know it's an interdisciplinary thing. I am sure that the solution to that will come from putting together some sort of task team, probably outside some existing agency.

What has to be done is to recognize that a human being is extremely frail in the combustion environment. I have to keep saying that to my firefighter friends and I have to keep telling myself that. As soon as the core temperature in my body gets 2 degrees above normal, I probably am going to be unconscious. Fire is a 1,700-degree phenomenon, my body temperature is 96, it gets to 108— too bad.

I have to breathe. Not only am I threatened by the heat, but I am very frail in the smoke and gas environment.

Mr. LEE. I think basic to your question, your last question, as I understood it is the capability of most fire departments to be able to identify the characteristics, combustion characteristics, of the chemicals as they encounter them. No firefighter is capable of storing it but must of our dispatch centers have indexed these characteristics and provide them to the firefighter on the scene.

Mr. MCGRATH. I guess what I am after is who is doing this research. And if they are, how are they getting that information to the firefighter.

I find the longer you are in the fire service, the more careless you get in your own personal safety. I know my brother doesn't use all of the equipment that is available to him any longer. They just rush in, get the job done, and they're out. I guess there's no way to legislate that. It's probably just a way of having their chiefs and lieutenants crack down on them. But the fact is, particularly in the city where you have the types of fires you do and as many as you do and particularly if you're in a place like the South Bronx, where my brother is, where you have 10,000 runs a year, you just become a little bit careless with your own personal safety. I don't think that's good either.

Dr. BRYAN. It's perception of risk.

Mr. MCGRATH. You do it so often and nothing happens, so you know you just continue being careless.

Dr. BRYAN. Could I make one comment on your earlier question about the research? The Center for Fire Research has had the only sustained basic fire research program in the United States for years. With an institution like Harvard they have done more extensive research on the effect of furnishings, different materials, rates of burning. This fire-modeling project they have going on involves Notre Dame, as well as Harvard, University of California, so I would have to say they are the only ones doing it now.

Mr. MC GRATH. One other thing is on the building codes. With new technology and new ways of building new buildings, and new materials going into that, is somebody passing on that information to local governments in order to update their building codes or to even, if they find that some of the old methods of construction were faulty, as far as safety goes, upgrade the codes of those buildings.

Dr. **Bryan**. There's an ongoing program funded by the Center for Fire Research, the Fire Administration, and the NFPA. NFPA sends out investigative personnel, technical people, to look at what were the aspects of factors involving ignition, the fuels, the structure. That information then is provided to all three of those agencies, NFPA provides it into their code-making process, the Center for Fire Research uses it in relation to their research programs, and the Fire Administration tries to integrate it into their educational training efforts for the fire service.

That cooperative arrangement has gone on for a number of years and is designed to learn from the fire incidents and make this information available to the interested agencies.

Mr. **McGrath**. Ought there be a single fire code for each State or should local government have their own?

Dr. **Bryan**. I think that we have, right now, in the United States, three regional building codes, each of which has a fire prevention code. I would have to say that due to the expertise the regional groups are able to get together on their committees for development. I think the best solution, and many communities do it, is to take one of the regionally developed NFPA or building code groups, and then modify them to the local areas. That way you get expert expertise in your basic requirements but you can still develop the local requirements you need that a national coded—a national/regional code doesn't have or doesn't have any acquaintance with or experience with.

Mr. **McGrath**. Provided they don't lessen the code. They can add to it, make it more stringent, but they can't lessen the code at the local level, am I correct?

Dr. **Bryan**. Yes; but there's an interpretation of what you mean by those terms: "strengthen and lessen."

Mr. **McGrath**. I have no further questions.

Mr. **Walgren**. Well, on behalf of the subcommittee, I want to express our appreciation very much for your testmony. It has been very helpful and will be a good guide.

The last panel is made up of John Rhodes, the chief operating officer, Factory Mutual Research Corp., and Phil Schaenman, of TriData Corp.

Gentlemen, welcome to the subcommittee. Let me say that your written statements will be made part of the record and please feel free to summarize or communicate for the record as best you feel. We'll start with Mr. Rhodes.

[The biographical sketch of Mr. Rhodes follows:]

Factory
Mutual
System

Biographical Sketch

JOHN M. RHODES (Jack)

Vice President and Chief Operating Officer

Factory Mutual Research Corporation

Born - United States Citizen (Pennsylvania)

Grew up and educated in Delaware

Graduate Chemical Engineer, University of Delaware 1940

Joined Factory Mutual 1940 and with them ever since except five years Military Service (W.W.II - Artillery Unit Commander MTO/ETO)

Served Factory Mutual as:
- (a) Field and Laboratory Engineer
- (b) Engineer in Charge, Test Center
- (c) Assistant Director, Laboratories
- (d) District Manager, St. Louis
- (e) Director of Engineering
- (f) Director of Research
- (g) Chief Operating Officer

Registered Professional Fire Protection Engineer, Massachusetts

Charter Member and Fellow Society of Fire Protection Engineers

Member National Fire Protection Association

Active Civic and Church (United Church of Christ) Affairs

Contributor to Fire Protection Literature

JMR
12/1/81

STATEMENT OF JOHN RHODES, CHIEF OPERATING OFFICER, FACTORY MUTUAL RESEARCH CORP.

Mr. RHODES. As chief operating officer of the Factory Mutual Research Corp., I speak also for the Factory Mutual System.

Factory Mutual System, incidently, is a group that provides property damage loss-control guidance for approximately three-quarters of a trillion, dollars worth of industry. Most of it in the United States.

We support the Fire Prevention and Control Act, the Center for Fire Research, and the U.S. Fire Administration, but my remarks are primarily with respect to the Center for Fire Research.

We speak in opposition to the proposal that their funding be discontinued. I think about the kindest thing that can be said for that proposal is that it is at least a classic example of pennywise and pound foolish.

While it's probably inadmissible testimony, I'll take the risk just the same, and point out that these remarks are being made by a congenital Republican and a dyed-in-the-wool believer in a balanced Federal budget.

Just looking around this room, as I've been doing, off and on, during our presence here, gives me a very deep impression of what can be done with a well-conceived and well-coordinated attack on a problem.

The particular problem illustrated here is that of friendly fire—space-launch rockets. And specifically the control of very, very high rates of combustion. The other thing that is impressing me here is that there isn't a single illustration here, with the exception of the bust of Dr. Goddard in the cabinet, that doesn't represent an expenditure vastly larger than the money we are talking about here with respect to unfriendly fire. We feel it would be not in the public interest to discontinue funding of the Center for Fire Research.

That's the end of my oral statement.

[The prepared statement of Mr. Rhodes follows:]

Factory Mutual System

Factory Mutual Research

1151 Boston-Providence Turnpike
P.O. Box 688
Norwood, Massachusetts 02062
Telephone (617) 762-4300
Telex 92-4415

J. M. Rhodes
Chief Operating Officer

March 3, 1983

U. S. House of Representatives
Committee on Science and Technology
Subcommittee on Science, Research and Technology
(The Honorable Doug Walgren, Chairman)

Subject: The NBS Center for Fire Research, and the Federal Fire Prevention and Control Act

Honorable Committee Members:

As we understand it, the fiscal 1984 budget proposal to the Congress would eliminate the National Bureau of Standards Center for Fire Research (CFR), a saving of about $6 million, with the expectation that the private sector and possibly state and local governments will increase their support of fire research.

The group of mutual insurance companies comprising the Factory Mutual System is, through this organization, the principal private-sector supporter of fire research in the nation. The attached brochure summarizes our activities. Our comments on the CFR may be of interest to you.

Firstly, we believe that the CFR does highly worthwhile work, aimed primarily at the life-threatening aspects of residential fires. Our own internally funded research is aimed primarily at improved protection of industrial and commercial properties ("highly protected risks").

About one-fifth of our research funds are spent for basic fire research studies, the results of which could apply equally well in many cases to either life-threatening residential fires or property-threatening industrial fires. In addition to our own funds, we have had funding, directly or indirectly, from CFR over the past few years sufficient to double our basic fire research activity; that is from a level of about $300k internally funded to about $600k jointly funded annually.

Secondly, our own internal commitment to fire research in 1982 was approximately $1.8 million, but our recently approved 1983 budget will require a 20% reduction in this effort. Some personnel are being terminated. Our overall business activity will not support a greater effort level. Hence, if CFR is eliminated we will not be able to pick up any of the load. Past state and local government funding of fire research does not indicate an ability to absorb the load either.

Thirdly, the basic fire research effort of the nation consists almost entirely of the CFR effort, some university programs supported by CFR, and our own effort. The combined effort is not robust. If CFR disappeared, it is probable that our basic effort would disappear too. What we could fund ourselves would not be viable; the group would be too small to do meaningful work. Such researchers are rare birds. Once they have had to fly elsewhere, getting them back may be impractical, if not, in fact, impossible.

Finally, it is our considered opinion that continued funding of the Center for Fire Research of the National Bureau of Standards at the requested level is fully justified, and in the best interest of society. We strongly urge that funding be approved by the Congress.

In regard to aspects of the Fire Prevention and Control Act not related to CFR, we generally believe the Fire Academy and the federal collection of fire statistics to be useful, but have no close connection with these activities. We strongly approve the recent efforts of the U. S. Fire Administration to promote widespread use of automatic sprinklers for life safety.

Very truly yours,

J. M. Rhodes

JMR:ema

Enclosure: "Factory Mutual Research" P7927

Mr. WALGREN. Thank you very much, Mr. Rhodes. The background information that you are a "dyed-in-the-wool", if that is the way you framed it, I don't want to put words in your mouth, is most important and most admissible because we really believe that there is some common ground regardless of political perspective that we can reach when something is truly in the national interest. I'm really glad that you added that aspect to your testimony because that will be very meaningful for many members of the committee.

Certainly, somebody who is as involved in this area as you are sees the value of the private sector and the contribution that the private sector makes in this area, and is in a position to appreciate that value, and yet can have such a clear conclusion of the value of this public sector effort carries a great deal of weight.

Let me turn to Mr. Schaenman and then perhaps we can talk about related issues after that testimony.

Mr. Schaenman.

[The prepared statement of Mr. Schaenman follows:]

BIOGRAPHY

Philip S. Schaenman

Mr. Schaenman is President and Co-Founder of TriData Corporation, a new member of the SPC Group based in Arlington, Virginia. TriData specializes in data analysis and management information for industry and government, especially in the areas of safety, health, and the environment.

From 1976 to 1981, Mr. Schaenman served as Associate Administrator of the U.S. Fire Administration, and was in charge of the National Fire Data Center. He directed national programs in fire protection technology and data. This included development of the first nationwide fire incident reporting system; breakthroughs in low-cost sprinkler systems for buildings and firefighter protective outfits; and investigation of major fires.

Prior to government service, Mr. Schaenman was a Senior Research Associate at The Urban Institute, Washington, D.C., where he managed projects to develop methods for measuring the performance of state and local government services, and the impacts of land development. At Bellcomm, Inc., a subsidiary of AT&T, Mr. Schaenman headed groups developing corporate management information systems and computer technology and applications for the manned spaceflight program.

Mr. Schaenman has co-authored several books on data systems and data analysis, and has been an instructor and international consultant in these areas.

Mr. Schaenman has a Professional Degree in Electrical Engineering from Columbia University, an M.S. in Electrical Engineering from Stanford University, a B.S. in Electrical Engineering from Columbia University, and a B.S. from Queens College, N.Y.

STATEMENT OF PHILLIP SCHAENMAN, PRESIDENT, TRIDATA CORP.

Mr. SCHAENMAN. Mr. Chairman, following what Mr. Rhodes said, I might say that I worked for 9 years on the space program, planning computer technology for it before I became associate administrator of the U.S. Fire Administration, trying to help develop the National Fire Data Center.

I recently completed a study on ways in which Europe approaches fire protection and I just want to briefly summarize some of the ideas from the study that we might use in shaping our own programs.

We have known for some time that the United States and Canada have the highest fire death rates in the world. Our death rates are double that of Europe and four to five times higher than in some countries.

Europe now is at the level of fire safety that was originally set as the goal for the U.S. Fire Administration and the Center for Fire Research when our charge was to reduce the fire death rate in half in a generation.

The question is how do they do it? The answer seems to be by placing a great emphasis on fire prevention, especially for residences, where 80 percent of our fire deaths occur.

Europeans seem to be much more aware of the importance of fire safety than we are. Part of this comes from their history of the burning of many cities in the last several hundred years, and more recent experience in the wars of this century.

Earlier today we had Martin Grimes from the National Fire Protection Association, and he was a firefighter in the Battle of Britain. He has a lot of first hand experience on how those fires were really brought home to a large portion of the public in Europe.

They stress fire safety to their children at home. They provide the political support for strong local and national government efforts in fire prevention.

The European fire protection community reinforces these attitudes with public education programs that try to reach a large percentage of the national population, not just those who wish to pick it up. They try to do that at least once every few years.

Here in the United States we have excellent programs that the National Fire Protection Association, FEMA, and insurance companies, and smoke detector manufacturers have developed. We have many excellent programs on the State and local level. We probably try most of the things that have been tried in public education in Europe. My impression is that our public awareness of fire safety practices is much less than Europe and that we need to increase our public education of fire safety, especially with regard to preventing the leading causes of fire which we can now identify through our data systems.

Europeans put a great deal of emphasis on building fire safety into their buildings. In most countries they review not only the plans of new buildings, but also alterations to buildings, even minor alterations. These reviews are usually made by fire brigade officers, though they may be made by insurance departments or staff from local mayors' offices or building department. In fact, senior officers in Europe consider plans review of buildings one of the most important parts of their job.

They do that in the rural areas as well as in the cities. I mention that because the fire death rate in our rural areas is double that in even the large cities over 1 million population.

In Europe many countries pay a great deal more attention to consumer product safety than we do. Many products must be tested before they can be marketed. Many products are covered in codes.

We may not want to go as far as they do, but we should continue that vigorous monitoring of product safety and encourage and support Underwriters Labs, and Factory Mutual, and other testing organizations.

Their philosophy of insurance is different than ours. If someone has a fire there they believe they should not profit from it. The result of that philosophy is that in many countries, they do not pay all your insurance unless you rebuild essentially the same building on the same spot.

Some countries will not let you insure 100 percent of the value of your building so that you have to take some loss if you have a fire, and therefore, try to stimulate you to be more safety conscience. You can not just say as we do, gee, do I get my insurance money?

There are many more fires related to heating in our country than in Europe and one of the reasons is their extensive use of chimney sweeps. That's an amusing concept to many of us, but the chimney sweep visits in many countries in Europe are mandatory.

The chimney sweeps not only clean the chimney; they provide advice on heating systems, they test them, they help install woodburning stoves. They are trained in their national fire academies. We may not want a mandatory chimney sweeps system. I doubt if that would be acceptable here. But we might consider improving their training and accreditation and the public awareness of their value.

Most European fire departments emphasize fire prevention—especially the building plans review and code enforcement—more so than here.

The average European fire officer receives far more training than his U.S. counterpart. He is likely to have a technical degree and he gets particular training in prevention.

The training of officers there is usually uniform within a country, which helps keep standards high and promotes mobility. They receive a great deal of training in prevention. Just to give one example, in France, to be a fire lieutenant you have to graduate from a special fire prevention school in Paris, in addition to the other training you receive.

In firefighter health and safety the firefighter's job there is much safer than here. We have as good or better protective clothing than they do, but more of them are equipped with their protective clothing; they are more likely to use it; they are more trained in safety; they have fewer fires at which they are at risk; and the buildings in which they fight fires are likely to be safer and more up to code. They are not expected to take high risks to save property. The combination of those factors is a dramatically lower death and injury rate than our firefighters have.

What are the implications from some of these observations for the U.S. program? I think first FEMA and the rest of the fire protection community should continue to encourage and stress fire prevention. Many individual cities are now doing this. For example, the city of Little Rock has just taken a bold step in using some of its scarce resources to double its prevention bureau, and to increase inspections by line companies.

This move was partly stimulated by the U.S. Fire Administration's Operation Dixieland program of a few years ago.

I think we should stress educating our public about the ways to prevent the most common type of fires on a national scope. Try to reach every citizen at least once every few years.

Since we are not likely to get our vast country and over 25,000 fire departments turned around rapidly, especially in these austere budget times, it is essential that we target these programs to the most serious problems and to improve our data systems and analytical system in order to do that targeting.

In training officers the major thrust of our National Fire Academy, I think, is in the right direction. I think the problem is trying to get enough officers trained in enough courses through a variety of outreach programs. We are really a relatively underdeveloped country in that area, even today.

As a people, we are not likely to become as careful as the Europeans very soon and we can make up for part of that lack of carelessness with our technology. It gives us more freedom of choice in our environment, and it makes up for some of our mistakes. We now have detectors in two-thirds of our homes; we are making advances in sprinkler systems but we need much more development of that technology and improvement of its reliability.

I think the Center for Fire Research is absolutely crucial in developing that technology further.

The European success in fire protection is no accident. They worked hard at it. We actually have the fire service; the technology; the advertising know how; the data to do even better than they are. We need national leadership to make that happen and I hope we don't witness another generation of America burning before that time.

[The prepared statement by Mr. Schaenman follows:]

WHAT WE CAN LEARN FROM EUROPE'S SUCCESS IN FIRE PROTECTION

Statement of Philip S. Schaenman
President, TriData Corporation

Before the
House Committee on Science and Technology
Subcommittee on Science, Research, and Technology

March 16, 1983

Mr. Chairman:

I am Philip S. Schaenman, President of TriData Corporation of Arlington, Virginia. TriData, a subsidiary of the System Planning Corporation, specializes in management studies and information systems for fire protection and other local government services. From 1976 to 1981, I was the Associate Administrator of the U.S. Fire Administration in charge of the National Fire Data Center. I recently completed a study on the ways in which Europe approaches fire protection, and would like to summarize some of the ideas from that study that we might consider in shaping our own programs.

We have known for some time that the United States and Canada have the highest fire death rates in the world. Our fire death rate per capita is double that of Europe and four to five times higher than in countries such as West Germany, Switzerland, and the Netherlands. This gap is substantiated by National Fire Protection Association surveys; a U.S. Fire Administration/Georgia Institute of Technology project to refine international estimates; World Health Organization statistics; and the Tokyo Fire Department's worldwide survey of major cities.

Europe is now at the level of fire safety that was originally set as the goal for the U.S. Fire Administration and the Center for Fire Research upon their creation in 1975. We were "to reduce the fire death rate in half in a generation."

In 1980, while at the Fire Administration, I personally started research into the reasons for the differences between Europe and ourselves, with a particular eye toward identifying fire protection programs that might be adaptable to the U.S., or that might stimulate new ideas here. This work built on earlier exploratory studies undertaken by Georgia Institute of Technology at the request of the U.S. Fire Administration. Since leaving government service, I completed this study under a grant from The Tobacco Institute.

I would like to briefly summarize what I found to be some of the major reasons for the relative success of the Europeans and the implications for the fire programs of the Federal Emergency Management Agency and the National Bureau of Standards. This is just a sample of a rich array of programs that the Europeans have. To set the stage, let me start with a personal experience.

In the course of visiting Europe last September to do research for this study, I slept for three nights in the one manned fire station in Bern, Switzerland. This one fire station, albeit much larger than one of ours, protects the seat of government, the associated diplomatic community, the banks, and over 200,000 people in the city of Bern and its suburbs. Not one fire alarm was sounded during my stay.

How do they do it? The answer seems to be by placing a much greater emphasis on fire prevention, especially for the home, where 80 percent of our fire deaths occur. Their prevention programs can be considered in several dimensions:

- **Public awareness**
- **Code enforcement**
- **Insurance practices**
- **Chimney sweeps**
- **Fire prevention bureaus and prevention training**
- **Firefighter health and safety.**

Practices vary from country to country. Each idea discussed below is practiced in one or more countries. More specific information may be found in the report referenced at the end of this testimony.

Let us consider public awareness first.

PUBLIC AWARENESS

Europeans seem to be more aware of the importance of fire safety than we are. Part of this awareness comes from their history: the burning of many cities in the last several hundred years, coupled with the more recent experience of the wars during this century. Europeans want to preserve their cultural heritage and their family heritage. They stress fire safety to their children at home. They provide the political support for strong local and national government efforts in fire prevention.

The European fire protection community reinforces these attitudes with public education programs that attempt to reach a large percentage of the national population or all of a particular target group, such as all school children or all the people in a particular region at least once every few years if not annually. These widespread efforts are led by their national governments, the insurance industry, or fire protection associations. In general, the local fire service provides about the same level of effort on the average as we do in public fire education, except for these occasional nationwide drives. In some countries, the courts are used to reinforce public education. Switzerland goes so far as to occasionally fine those who start fires through carelessness, to remind them that society frowns on their action, much as we might do to someone who causes a traffic accident.

Here in the United States the National Fire Protection Association, FEMA, insurance companies, smoke detector manufacturers and others, have developed many excellent public education programs. We also have many state and local fire prevention programs, and they probably have attempted most of the European public education ideas in one community or another. But my impression is that public awareness of fire safety practices is greater in Europe than in the U.S., and that we need to increase our public education in fire safety, especially regarding how to prevent the leading causes of fire.

CODE ENFORCEMENT

Europeans put great emphasis on building fire safety into their buildings, with the goals of making it more difficult for fires to start, compartmentalizing fires that do start, and facilitating escape. In most countries they review not only the plans of new buildings, but also alterations to buildings. The reviews usually are made by fire brigade officers, though they may be made by insurance departments or staff from the local mayor's office or building department. In several of the countries I visited--Sweden, for example--senior fire officers considered plans review one of the most important parts of their job.

More discretion is given to the fire service in enforcing codes there than here, and the courts are more likely to back them. The Swiss, for example, have relatively slender code books with examples of what is allowable. They give builders the ability to substitute equivalent alternatives, with "equivalency" determined by the fire brigade, building, or insurance departments. They do this to make the codes clear to all concerned parties, yet be flexible to accomodate new technology or more effective approaches.

Buildings in rural areas as well as those in cities have their construction plans reviewed. A Swiss chief pointed out a chalet 5000 feet high in the Alps and said that even its plans were reviewed. The rural areas generally have the same strict codes as do cities. They are enforced by local or regional authorities (such as the county brigade in England, the canton authority in Switzerland, the local town in France). I note this rural attention because the fire death rate in rural areas in the United States is double that in large cities and triple that elsewhere.

Construction preferences as well as codes play an important role in built-in safety. A greater percentage of Europeans than Americans live in apartment buildings, which means that more people fall under the stricter codes applicable to those buildings. Single family dwellings are built to last generations and are more likely to be made with concrete, stone, or steel, which also builds in fire resistance and control. (That also increases their cost, and means that fewer can afford them.) Rooms are more likely to have doors on them, especially in Britain, and this can be crucial in containing fires and smoke.

CONSUMER PRODUCT SAFETY

In several European countries all electrical products, heating appliances and systems, and other gas-powered appliances must be government-tested and approved. Some countries share each others' test results to reduce the costs of testing, and abide by them. Woodburning stoves, fireplaces, and electrical wiring are regulated through codes, including their installation.

INSURANCE

The philosophy of insurance in Europe is that someone who has a fire should not profit from it. There is a parallel philosophy to preserve the appearance of the community. The result is that in several countries, only a fraction of the insurance is paid if a building equivalent to the one that burned is not rebuilt on the same spot. This practice removes much of the incentive for arson or fraud. Other countries do not permit insurance of 100 percent value; you will have a significant, though not catastrophic, financial loss if a fire occurs at all; and that, of course, increases the incentive to be careful.

CHIMNEY SWEEPS

There are proportionately far fewer heating-related fires in Europe than in the U.S., where heating is our leading cause of residential fires. One of the reasons for the difference is the use of chimney sweeps. Chimney sweep visits are mandatory in several countries in Europe and are strongly encouraged in most others. Most homes are visited from one to four times a year by sweeps. The sweeps often provide advice on heating systems and woodburning stoves, and help test and maintain them. Sometimes the chimney sweeps also perform fire safety inspections. The sweeps often are trained at national fire academies, and serve apprenticeships. We are not likely to want a mandatory chimney sweep system, but we might well consider improving the training and accreditation of chimney sweeps, and public awareness of their value.

FIRE PREVENTION BUREAUS AND PREVENTION TRAINING

Most European fire departments emphasize fire prevention--especially building plans review and code enforcement--more so than in the United States. Senior fire officers in Europe spend the majority of their time on prevention.

The average European fire officer receives far more training than his U.S. counterpart, especially in prevention, and also greater technical education, often in the form of an engineering degree. The training of officers is usually uniform within a country, which keeps standards high and promotes mobility. Senior officers often must have experience in several cities before qualifying as chief of a large city. Fire officers all receive extensive training in prevention, as well as in handling a variety of non-fire emergencies. In France, to be a fire lieutenant you must graduate from a special fire prevention school in Paris.

FIREFIGHTER HEALTH AND SAFETY

Not only are our civilian fire death (and injury) rates high, but our fire service personnel also have exceptionally high fire death and injury rates. The European firefighter has a safer job, even though some of the best protective clothing is available in the U.S., and FEMA is making further strides in this area, with testing of a new generation of protective clothing in Project Fires. European firefighters are more completely and uniformly equipped, are more likely to use their safety equipment, and receive more safety training. At large fires, there is likely to be a safety officer. They also are not expected to take high risks to save property. These factors, coupled with a lower rates of fires in buildings, result in dramatically lower death and injury rates there for firefighters.

IMPLICATIONS FOR THE U.S. PROGRAM

There are several broad lessons to be learned from the European approach to fire protection. First, FEMA and the rest of the fire protection community should continue to encourage fire prevention. Many individual cities are doing this. For example, the city of Little Rock, Arkansas, has just taken the bold step of using some of its scarce resources to double its fire prevention bureau, and to increase inspections by line companies. This move to reduce the incidence of fires and apprehend arsonists was stimulated, in part, by the U.S. Fire Administration's Operation Dixieland Program.

Educating the public about ways to prevent the most common types of fires, as well as ways to cope with fires that do occur, should be encouraged on a national scope toward the goal of reaching every citizen at least once every few years. Special programs should be targeted to the highest risk groups.

Since we can't get our vast country and its more than 25,000 fire departments turned around rapidly, especially in these austere times, it is essential to be able to target the programs that can be afforded to the most serious problems. To do this targeting, good data is needed. It is also needed to evaluate the effectiveness of particular programs over time, and to identify new, emerging problems. Therefore, data from The National Fire Incident Reporting System (NFIRS) and other sources should continue to be collected and analyzed in detail. The more than half of the nation's fire departments not yet participating in NFIRS should be encouraged to do so. Fire departments should be given further assistance in how to analyze and use the data for managing their problems. Much use is being made of the National Fire Incident Reporting System data by industry as well as by the fire service, but the full potential of the data in guiding fire protection remains to be reached. Also, the quality of the data needs to be monitored and improved to build confidence in its use and to avoid misuse.

Training of officers--the major thrust of the National Fire Academy--should be increased to the point where all of our nation's fire officers receive adequate training. There are still many officers in this country who receive either no training upon promotion to officer, or attend only an occasional course. There is even less training for chief officers. We are an underdeveloped nation compared to several European countries in this area. The National Fire Academy's programs need support to reach more officers and specialists, either directly through on-campus and outreach programs, or by training trainers for state and local facilities. In my opinion, the curriculum described in the latest National Fire Academy catalogue is exactly on target in the new courses such as Plans Review. The problem now is getting enough officers trained in enough of the courses or their equivalent.

We as a people are not likely to become as careful as the Europeans are in fire safety soon. They have been working the problem for generations. Our technology, however, can both make up for some of our carelessness and also give us more freedom of choice in our environment. Smoke detectors, sprinklers, and other technology can help make the difference. We have detectors in two thirds of our homes, they have them in almost none. Further improvements in detector usage and maintenance are needed. Better identification of ways to design buildings, treat fabrics, and make other materials fire resistant should be explored. We need to recognize and encourage the Center for Fire Research at the National Bureau of Standards to provide the leadership and objectivity in fire research, as well as the funds for filling gaps left by industry. The National Bureau of Standards program is respected around the world, and helps us gain access to other technological advances, through international exchanges, as well as by their direct contributions.

The European success in fire protection is no accident. They have worked hard to achieve it, and have made the strategic decision to emphasize prevention. We have a proportionately larger and better equipped fire service, we have a much wider spread of smoke detection and automatic suppression technology, we have better data on our problems, and we certainly don't take a backseat in building technology or public education capability. We have the potential to beat even the European record, provided the national leadership to make it happen. I hope we do not have to witness another generation of "America Burning" before this comes to pass.

Those interested in further details on European fire protection practices may obtain a copy of the report entitled, "International Concepts in Fire Protection," Philip S. Schaenman, December 1982, from TriData Corporation, 1500 Wilson Boulevard, Arlington, Virginia 22209.

Mr. **Walgren**. Thank you very much.

I would like to again underscore that the testimony on the Center for Fire Research seems unequivocal. And that fact alone is noteworthy.

I want to express my appreciation to both of you. I want to say how much I appreciate your testimony. We're going to look at them with real interest in our efforts to reduce this Nation's alarming fire problem.

Thank you very much.

[Whereupon, at 12:44 p.m. the subcommittee was adjourned.]

APPENDIX I—Letters and Statements from other Federal agencies which have programs that contribute to an understanding of the fundamental problems related to earthquakes or steps which reduce the hazards of earthquakes

NASA

National Aeronautics and
Space Administration

Washington, D.C.
20546

ply to Attn of C:LCM:djm:C-8617f

JAN 21 1983

Honorable Doug Walgren
Chairman
Subcommitte on Science,
Research and Technology
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

This is in response to your letter to Mr. Beggs requesting information related to NASA's ongoing research programs which contribute to an understanding of fundamental problems related to earthquake occurrence. NASA research in this area is conducted under the Geodynamics Program of the Earth and Planetary Exploration Division in the Office of Space Science and Applications.

The Geodynamics Program is involved in the measurement of global tectonic plate motion and the regional crustal deformation occurring at plate boundaries where most earthquakes occur. An outline of NASA Geodynamics program plans for these studies is provided in Enclosure 1. The status of the program has been reported annually to the international scientific community both in annual reports, copies of which are enclosed (Enclosure 2) for 1979, 1980, and 1981, and in an annual conference held in the Washington area. The Annual Report for 1982 is in preparation.

The NASA activity is part of a five-agency program involving NOAA, USGS, NSF, and DMA. A copy of the interagency agreement is attached (Enclosure 3). This agreement outlines a program of study of the application of space technology to crustal dynamics and earthquake research and describes the participation of each agency in these studies. In addition, we have been coordinating our activities with FEMA and have provided FEMA our research plans for inclusion in the National Earthquake Hazards Reduction Five-Year Program Plan which they are preparing.

Sincerely,

John F. Murphy
Assistant Administrator
for Legislative Affairs

Enclosures

Enclosure 1

NASA Geodynamics Program

The NASA Geodynamics Program conducts measurements and analyses associated with studies of regional crustal deformation, contemporary tectonic plate motion, plate deformation, earth rotational dynamics, and lithosphere structure and evolution.

The program makes use of methods developed for precise satellite tracking and radio astronomy research, in order to measure variations in the earth's polar motion and rotational rate, and changes in positions on the earth surface which are related to crustal motion. These methods involve laser ranging to man-made satellites and to the Moon, and microwave interferometry using signals both from astronomical radio sources and from satellites.

Understanding the internal dynamics of the Earth, including the movement and deformation of its crust, is important to achieving the goal of understanding how and why earthquakes occur. Since crustal movements are typically of the order of a few centimeters per year, observations in many tectonic areas are needed over an extended period of time, in order to assure validity of measurements and to study differences in crustal strain associated with local geological conditions. The observations using space methods are also fundamental to our ultimate understanding of how and why the tectonic plates move, and whether a relationship exists between variations in Earth rotation and earthquake occurrence.

NASA measurements of crustal motion and deformation began in 1972 with the application of satellite laser ranging to the measurement of the relative motion of the North American and Pacific Plates at their boundary along the San Andreas Fault Zone in California. Through the 1970's the laser ranging and microwave interferometric techniques were developed to the point where relative baseline length changes of the order of a decimeter were detectable over distances of many hundreds of kilometers; for instance, over a period of eight years, the San Andreas Fault Experiment detected a relative motion of the North American and Pacific Plates of 8±3 cm/yr, using stations approximately 800 km apart.

In 1980, a Crustal Dynamics Project was established at the NASA Goddard Space Flight Center to further refine the measurement methods and to begin a global program of measurement and analysis. It is currently projected that by 1984 the laser ranging and microwave interferometric methods will produce measurement precision of a few centimeters over distances of several thousand kilometers. The NASA project is cooperating with laser and microwave interferometry stations in over a dozen countries, and it includes 60 investigations conducted by scientists in the United States and sixteen other countries. In addition to this Project activity, theoretical studies of plate motion modeling, fault rupture mechanisms, gravity field modeling, and the Earth's internal structure and composition are being funded at NASA Centers and at universities.

The Geodynamics program relies heavily on a broad-based federal program which will apply these data to the earthquake problem and provide for phased transition of measurement techniques and operational monitoring to other agencies, and on an expanded international activity which will minimize the

U.S. investment. The program is conducted through an interagency agreement with NOAA, USGS, NSF, and DMA. The agreement, which was concluded in 1980, provides for an interagency coordinating committee, a program review board, and the development of a Federal implementation plan. Plans have also been formulated for the assumption by NOAA of the crustal motion measurements initiated by NASA, beginning in 1984, as part of the NOAA National Crustal Motion Network.

The goals of the NASA program are:

(1) to model crustal strain changes in the western U.S. and Alaska, and at similar tectonic boundaries, in order to understand how crustal deformation is related to earthquake occurrence;

(2) to produce (over a period of ten to twenty years) models of the presentmovement and deformation of the major tectonic plates, and to understand the forces driving the plates;

(3) to identify the causes changes in polar motion and Earth rotation;

(4) to study internal dynamics of the Earth;

(5) to formulate an integrated, comprehensive global model of dynamic processes.

1. Regional Crustal Deformation

Studies of regional crustal deformation involve measurements of the changes in baseline lengths at sites located from 200 to 500 km from a plate boundary. These measurements are made both by mobile laser ranging systems and by microwave systems, operating in conjunction with comparable fixed stations. Measurements are required at a frequency of once or twice per year, depending on the velocity of the crustal motion.

In FY 1981 measurements were obtained at 15 sites in California and several other sites in the western U.S. In the current program, it is planned to repeat measurements at each of these sites (and to add others) through 1985. In 1984, initial measurements of deformation in Alaska and in Mexico will begin. Similarly, in 1985 limited measurements (at two sites) will be initiated in South America. Also, special mobile laser facilities are being constructed by The Netherlands and the Federal Republic of Germany for joint studies with the U.S. in the Eastern Mediterranean and elsewhere, beginning in 1984.

The current program is deficient in that studies of deformation at the subduction boundary on the western coast of South America (which is similar to the subduction boundaries off the south coast of Alaska and the Pacific Northwest) and on the Alpine Fault in New Zealand (which is similar to the San Andreas Fault) are not included. However, the U.S. expects to participate with a consortium of European countries in studies of the Anatolian Fault in Eastern Turkey (similar to the San Andreas Fault). These studies are important in interpreting the measurements in the western U.S. and Alaska, and in particular, in avoiding earthquake modeling ambiguities which maybe associated with the particular geology of the U.S. areas.

2. Present Plate Motion

The detection and monitoring of present plate motion involves measurements by fixed laser and microwave facilities located on the various major plates. A minimum of three similar facilities on each plate are required in order to measure the rate and direction of motion of the plate. Because the motion of the plates is generally small (0 to 18 cm/yr) measurements are generally required only several times per year.

Under the Crustal Dynamics Project, measurements have begun of plate motion with specific emphasis on the North American, Pacific, Australian, South American, and Eurasian plates. This has been accomplished with U.S.-owned laser systems deployed both within and outside the U.S., and through coordinated observations with fixed laser and microwave facilities operated by other countries (particularly Germany, France, and The Netherlands). The current program provides for continuation of these studies, at least through 1988, for beginning joint U.S.-Japan studies of Pacific Plate Motion in 1984, and for initiation of Nazca-South American Plate measurements in 1983.

Plate motion is an important factor in understanding the accumulation and release of crustal strain at plate boundaries. The only information available on plate motion, other than that being obtained by space methods, is derived from geological data averaged over extended periods. There are indications that plate velocities may be episodic rather than constant. If this is true, the monitoring of plate motion on a regular basis and over an extended period will be critical to earthquake studies.

3. Plate Deformation

Most earthquakes occur at or near plate boundaries. However, the occurrence of earthquakes in plate interiors, including the two largest earthquakes recorded in the U.S., is unexplained by current theories. Indeed, even the question of whether plates are rigid or are capable of significant internal deformation is presently unanswered. The initial NASA effort has concentrated on studying the internal deformation of the North American plate, in order to seek clues about the causes of intraplate earthquakes (e.g., that in the New Madrid area in 1812). Data acquired over a four-year period has placed an upper bound of 0±0.5 cm per year change in the horizontal baseline between the east and west coasts of the U.S. The North American deformation measurements will be extended in 1984 in a joint program with Canada. Studies of the deformation of the Pacific plate were initiated in 1980 and will be continued through 1988.

To further resolve North American Plate deformation, additional sites in the middle and eastern portions of the U.S. are required. In addition, measurements on the Pacific Plate, which is composed of thin oceanic crust, should be augmented by additional sites in the western Pacific. Also, studies of the Australian plate, which by all evidence is very stable, should be conducted for comparative purposes.

4. Earth Rotational Dynamics

Monitoring of the Earth's polar motion and rotation rate has been done by an international network of astronomical stations for over a hundred years. This information is significant for earthquake studies. The possibility has been suggested of a causative relationship between short-term variations in polar motion and the occurrence of major earthquakes. Unfortunately, until recently the accuracy of the polar motion measurements has been inadequate for detailed studies of this relationship.

The current capabilities of laser ranging and microwave technique permit determination of short-period (five-day) variations to accuracies better than 10 cm, an order of magnitude better than classical methods. A worldwide network of carefully located stations is required to achieve the accuracies needed. This is now being accomplished by NASA laser stations and by a network of microwave interferometric stations being established by NOAA with NASA's assistance. In addition, under the auspices of several international groups, tests and comparisons are to be conducted, starting in late 1983 and extending through 1984, of the space techniques available for Earth rotation monitoring. The object of these tests is to select methods for a new international system to be implementated later in the decade.

5. Lithosphere Structure and Evolution

NASA supports studies of the lithosphere using data acquired from satellites, including modeling of the Earth's gravity field. This work is important to our understanding the structure and deformation of the solid Earth, and fluid convection in the mantle. These studies are also important for resolving the question of the relative importance of several candidates for the major forces which drive the plates.

Continued studies are needed to resolve these questions. These studies would be aided considerably by actual detection of mantle convection and by determination of the size and scale of convection cells, which requires gravity field models with improved accuracy and resolution. To some extent this can be accomplished by improvements of the current field models. However, to achieve the accuracies and resolution needed, better surveys of the Earth's global gravity field are required. Studies of a satellite concept (The Geopotential Research Mission) for acquiring the needed information have been conducted by NASA. The mission concept and technology is sufficiently defined to warrant development of the Geopotential Research Mission for a flight in 1988 which would produce improved gravity field models by 1990.

Enclosure 2

NASA Technical Memorandum 85126

NASA Geodynamics Program: Annual Report for 1981

Geodynamics Program Office
Office of Space Science and Applications
Washington, DC 20546

NASA
National Aeronautics and
Space Administration

**Scientific and Technical
Information Branch**

1982

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I. INTRODUCTION

This document is the third annual report of the NASA Geodynamics Program. Its purpose is to inform interested agencies and individuals of the status, progress, and plans of the program. The intention of the Geodynamics Program Office is to issue similar reports each year.

The first of these annual reports (NASA, 1980) contained a section of background and historical information, to bring the reader up to 1979 since the beginning of the program as the National Geodetic Satellite Program. The second annual report (NASA, 1981a) highlighted the progress in instrumentation development and theoretical research, and the preparation for initiation of crustal motion measurements in the western U.S. This report also included a list of publications of research results supported by the Program.

This, the third annual report of the Program, reflects the considerable progress made in 1981, both in achieving improved measurement precision and in establishing the foundation for the acquisition and analysis of scientific data.

The investigations and investigators in the Geodynamics Program and the publications related to the Program are listed in the appendices.

HIGHLIGHTS AND ACHIEVEMENTS OF 1981

The NASA program advanced broadly in 1981 towards the objectives of understanding the earth's crustal motion, deformation and rotation dynamics; and of achieving improved models of the earth's gravity and magnetic fields.

The principal highlights of 1981 were:

1. The selection of 57 Crustal Dynamics Project Investigations, including 16 from other countries.

2. The initiation of baseline measurements in the western U.S. from 23 sites, using mobile VLBI and laser ranging stations.

3. The analysis of over 40 VLBI determinations of the 3,928 km baseline between Westford, MA, and Owens Valley, CA. Over a five year period there is no detectable change in baseline length between these stations within ±0.5 cm/yr. The individual measurements had a precision of better than ±3 cm rms.

4. The measurement of baselines between American VLBI stations (Westford, MA; Ft. Davis, TX; and Owens Valley, CA) and European VLBI stations (Onsala, Sweden; Bonn, West Germany; Chilbolton, England) to a precision of 3 cm. In addition, the global

laser network operated throughout the year for repeated measurements of baselines between stations on the North American, Pacific, South American, Australian, and Eurasian Plates. Regular determinations of five-day values of polar motion and length of day were also made.

5. The Polaris VLBI station at Westford, MA, was completed and NOAA initiated routine measurements of polar motion and UT. The results to date have a repeatability of 3 milliarseconds in polar motion and 70 microseconds in UT1.

6. Very good agreement was demonstrated between polar motion determinations from VLBI, satellite laser ranging, and lunar laser ranging. The differences between BIH and these three systems were found to be real.

7. A very strong correlation was demonstrated between the changes in the measured length of day and the changes in atmospheric angular momentum computed from global weather data.

8. Sub-centimeter laser ranging precision was demonstrated, and procurement was initiated to upgrade Moblas 4-8 to this level of precision.

9. A new gravity field model for LAGEOS was developed, which has improved the precision of baselines and PM/UT by a factor of two.

10. Tracking accuracies of better than 0.3 micron/sec were demonstrated in the laboratory for application to satellite-to-satellite tracking measurements of the earth's gravity field.

11. The first vector field models of the earth's magnetic field and crustal anomalies were developed.

II. GEODYNAMICS PROGRAM OBJECTIVES, ELEMENTS, AND FUNDING

A. OBJECTIVES

The objectives of the NASA Geodynamics Program are: (1) to contribute to the understanding of the solid earth, in particular the long-term crustal processes associated with natural hazards and resources, and the structure and internal composition of the earth; (2) to develop models of the earth's gravity and magnetic fields for multidisciplinary science and applications needs; and (3) to facilitate the establishment of new geodynamics measurement services requiring precise position determination.

Achievement of these objectives depends on the development, demonstration, and use of techniques for measuring crustal motion and deformation and on improved measurement of the earth's gravity and magnetic fields. The program includes research in modeling of crustal processes, earth rotational dynamics, and geopotential fields; this research is a necessary part of the program. Studies of new instrumentation and space mission concepts are also supported.

The principal space techniques now available for precise measurements of crustal motion and deformation, polar motion, and earth rotation are very long baseline microwave interferometry (VLBI) using signals from extragalactic radio sources or from satellites, and laser ranging to the moon and to man-made satellites such as Lageos. The VLBI and satellite laser ranging methods employ both fixed and mobile stations.

In 1981 the Office of Space and Terrestrial Applications and the Office of Space Science were recombined into the Office of Space Science and Applications; however, the scope and objectives of the NASA Geodynamics Program (which was relocated to the Earth and Planetary Exploration Division within the newly formed OSSA) were not affected by this reorganization.

B. PROGRAM ELEMENTS

1. Global Earth Structure and Dynamics. The objective is to improve our understanding of the dynamics of the earth by development of models of polar motion and earth rotation, global plate motion, and the dynamics of the core; and to improve our understanding of the global structure of the earth, including its crustal magnetization, gravity field, and the evolution of the crust and lithosphere. Formulation of a standard dynamic earth model will be attempted under this program element.

2. Regional Crustal Deformation Modeling. The objective of this element is to conduct modeling studies of crustal deformation in various tectonic settings. These studies are needed to assist in determining what measurements are required and to provide a proper perspective for analysis of data acquired by the

Crustal Dynamics Project. The main types of models involved are earthquake mechanism, accumulation of stress and strain, and vertical motion.

3. Lithosphere Structure and Evolution. In this element, studies are conducted which are related to the processes which have formed the lithosphere, in order to gain a better understanding of the dynamic mechanisms that are active at present. Under this program, element models are being developed that relate to the current state, origin, evolution, and dynamics of the lithosphere. The objective is to derive plate-driving mechanisms, including mantle convection, to explain current plate motion measurements. Emphasis is placed on understanding the nature of subduction and collision zones and lithosphere/mantle rheology.

4. Geopotential Field Models. The objectives of this element are to develop gravity and magnetic field models, to investigate data analysis techniques and software systems, and to support the Non-Renewable Resources and Ocean Research Programs as well as other elements of the Geodynamics Program. Emphasis is placed on use of satellite altimetry and determination of the maximum resolution that can be achieved in the gravity field analysis with existing data. Magnetic field models (including secular variation) are developed in this area of the program. The development of a data base for ancillary information required for geodynamics investigations, such as gravity anomalies, topography, and bathymetry, is maintained under this element.

5. Advanced Geodynamics Instruments and Missions. These studies support the development of new methods for making geodynamics measurements using space systems and techniques and the development of advanced space mission concepts.

These program elements are supported through three principal activities:

a. A Crustal Dynamics Project (CDP) which is managed by the Goddard Space Flight Center, assisted by JPL. The CDP is responsible for the development of laser and VLBI systems, the acquisition and processing of data, and the analysis of these data by approved Principal Investigators.

b. A NASA Laser Network which is managed for the Geodynamics Program by the Office of Space Tracking and Data Systems. The responsibility for the Network is at GSFC and includes operation of Moblas and SAO lasers and coordination of cooperating laser systems in other countries.

c. A research and technique development program which selects and funds theoretical research and advanced systems and missions work both at NASA Centers and at universities.

C. PROGRAM FUNDING

Funding for the NASA Geodynamics Program from all sources for FY 1980-82 and planned funding for FY 1983 is shown in Table 1. Overall funding for FY 1982 and 1983 is 23% less than funding levels required to continue planned program activities. To accommodate these budgetary limitations, it was necessary to: (1) delay several activities planned by the CDP; (2) extend the CDP by two years from a completion date of 1986 to 1988; and (3) reduce all laser ranging observations from two shifts (16 hours per day, five days per week) to one shift (eight hours per day, five days per week).

Work relating to the Magnetic Field Satellite (Magsat) Mission will be completed in FY 1983. Additional magnetic field work in FY 1983 will be funded either under the Geodynamics RTD or from other sources.

In Fiscal Years 1980-1982 the Geopotential Research Mission (GRM) studies were supported by both the Geodynamics RTD and Earth and Planetary Exploration Division Advanced Studies funds.

III. PROGRAM COORDINATION

The study of crustal deformation and earth dynamics has engendered broad interest on a national and international scale, because of its implications for understanding earthquakes and the emplacement of resources, its influence on geodetic surveying, and because of what it can tell us about the internal structure and dynamics of the earth. Considering the global nature of the solid earth sciences and the importance of both the measurement of plate motion and the observation of regional deformation under both similar and different tectonic settings, the involvement of other countries is a vital aspect of achieving the NASA program objectives. Consequently, the NASA program has from its beginning stressed coordination of observing systems and the transfer of advanced technologies to operational entities in the U.S. and to other countries.

A. NATIONAL COORDINATION

At the national level, the NASA Program is coordinated through an interagency agreement involving NASA, NOAA, USGS, DMA and NSF. This Agreement, concluded in September 1980, outlined the roles of these U.S. federal agencies in the application of space technology to crustal dynamics and earthquake research. The Agreement established both The Interagency Coordinating Committee for Geodynamics (ICCG) and a Program Review Board (PRB). Several meetings of the ICCG were held in 1981 to approve the selection of sites for mobile systems, to consider proposals submitted in response to the NASA Announcement of Opportunity, and to formulate plans for the transfer of system technologies. As stipulated by the Agreement, the PRB met in July 1981 to evaluate the interagency programs and plans.

A highlight in 1981 was the formulation by the ICCG and the approval by the PRB of a plan for the establishment of operational geodetic services using space technologies (ICCG, 1981).

B. INTERNATIONAL COORDINATION

In response to the NASA Announcement of Opportunity for Crustal Dynamics and Earthquake Research, investigations were approved for scientists from France, England, Germany, Sweden, Spain, Switzerland, Canada, Venezuela, New Zealand, Australia, Chile, and The People's Republic of China (PRC). By the end of 1981, proposals were also received from Peru and Bolivia; these proposals are being reviewed.

An agreement was initiated with The French Centre National d'Etudes Spatiales (CNES) for installation of a Moblas facility in the Society Islands in the Pacific. Negotiations were also begun for locating a Moblas station at Mazatlan, Mexico, and for loan of an SAO laser to The Italian Consiglio Nazionale delle Recerche (CNR). The SAO laser is to be installed by CNR and operated at their expense. The agreement with CNR also initiates studies of joint NASA/CNR development and launch of a second Lageos satellite, and NASA technical assistance in the development of mobile VLBI and laser stations.

The most important international development in 1981 was the progress made by other countries in establishing space geodynamics programs similar to the NASA Geodynamics Program. New laser ranging and VLBI equipment is being constructed or planned in Japan, The Netherlands, The Federal Republic of Germany, Italy, England, Australia, People's Republic of China, Switzerland, and Austria. As a result of this activity, the International Association of Geodesy (part of the International Union of Geodesy and Geophysics) established jointly with COSPAR a Commission on International Coordination of Space Techniques for Geodesy and Geodynamics (CSTG). CSTG has held several meetings, and has requested approval for establishment of a subcommission to coordinate programs using mobile VLBI and laser ranging stations.

Many of the European Crustal Dynamics Investigators have formed an informal consortium ("Wegener") to establish and coordinate a European program of crustal deformation measurements using the mobile laser ranging facilities now under development by the Delft University of Technology (The Netherlands) and the Institut für Angewandte Geodäsie (Federal Republic of Germany). NASA intends to participate in this program by positioning one of its transportable lasers in the Eastern Mediterranean as part of the observational campaign in 1985 (approximate date), and the developers of the European transportable lasers also intend to extend their participation in the NASA Geodynamics Program at a later date by operating their equipment in the Western Hemisphere.

The Ad Hoc Committee of Experts on Earthquake Prediction, part of the Council of Europe, is preparing a plan for a coordinated European program of earthquake prediction research; the plan is to be submitted to the Council of Ministers of the Council of Europe in December 1982. The activities of the Wegener Consortium are at the present time included in the draft program plan. Discussions were initiated in 1981 between the Wegener Consortium chairman, the Council of Europe, the European Space Agency, and NASA, aimed at arriving at an agreement concerning the use of transportable lasers for crustal deformation measurements in the Eastern Mediterranean area.

A new satellite laser ranging observatory is being built at Simosato, Japan, under the auspices of the Japanese Hydrographic Department, Maritime Safety Agency. JHD is also planning to construct a mobile laser ranging facility as part of its GS-1 Geodetic Satellite Mission. NASA and JHD are now discussing an agreement covering exchange of satellite laser data and technical information on mobile laser systems.

A satellite laser ranging observatory is nearing completion at the Institute of Seismology, State Seismological Bureau, at Wuhan in the central People's Republic of China. Discussions are being held between SSB and NASA concerning a laser data exchange agreement.

A VLBI experiment was conducted in 1981 between Bonn University's Effelsberg radio observatory and a smaller radio antenna at the Shanghai Observatory, People's Republic of China. The experiment will be repeated in 1982. Shanghai Observatory is constructing a 25m geodetic VLBI radio observatory, which should be in operation in 1985. Shanghai Observatory and NASA are considering extending the existing laser data exchange agreement to cover joint experiments and data using the new Shanghai VLBI facility.

VLBI experiments are planned for 1984 using NASA-operated VLBI observatories and the 26m radio telescope operated by the Japanese Radio Research Laboratories (RRL), Ministry of Posts and Telecommunications, at Kashima, Japan. NASA and RRL are considering extension of the existing agreement on the 1984 experiments to include a regular program of observations at Kashima and NASA stations throughout the lifetime of the Crustal Dynamics Project.

In 1981 the International Council of Scientific Unions (ICSU), at the request of the International Union of Geodesy and Geophysics (IUGG) and the International Union of Geological Sciences (IUGS), established a ten-year program on Dynamics and Evolution of the Lithosphere. The new program, a broadening and extension of the International Geodynamics Project, is coordinated by the Inter-Union Commission on the Lithosphere (ICL). At organisational meetings of the Commission in 1980 and 1981, working groups and coordinating committees were established on seventeen different aspects of modern research in geodynamics. The NASA activities in applying space technology to research in geodyamics are essential in accomplishing the objectives of the program. Two of the ICL bodies (Working Group #1, Recent Plate Movements and Deformation; and Coordinating Committee #1, Environmental Geology and Geophysics) are making use of the results of the NASA program, and include members who are also principal investigators in the NASA program or who are directly involved with interpretation of the NASA results.

IV. CRUSTAL DYNAMICS PROJECT

A. MEASUREMENTS

As part of the western U.S. regional deformation studies, mobile VLBI operations were conducted with base stations at Goldstone (DSS-13), CA; Owens Valley (OVRO), CA; and Ft. Davis (HRAS), TX. Baselines were measured between the base stations and the following sites occupied by MV-2 or MV-3: Pasadena, Palos Verdes, Pearblossom, La Jolla, Monument Peak, Pinyon Flat, Gorman, Santa Paula, Presidio, Pt. Reyes, Vacaville, Ft. Ord, and Vandenberg AFB, all in California, and Yuma, AZ. (Figure 1)

The TLRS operations in the western U.S. used base stations at Platteville, CO, Quincy, CA, and Monument Peak, CA. Baselines were measured from the base stations to TLRS sites at Bear Lake, UT; Vernal, UT; Owens Valley, CA; and Otay Mountain, CA.

For studies of plate deformation, VLBI measurements were made between Westford, MA; Owens Valley, CA; and Ft. Davis, TX. These show baseline length changes of 0±1.5cm/yr. These repeated individual VLBI measurements had a precision of better than ±3 cm rms.

In cooperation with other Federal agencies, an agreement was reached on the establishment by NOAA of a National Crustal Motion Network (NCMN) beginning in 1986. This Network (Figure 2) includes all of the U.S. sites selected for the CDP plus other sites of interest to NOAA. The Network will be monitored by NOAA using VLBI equipment transferred from NASA.

For studies of plate motion, baselines were measured using fixed VLBI stations in the U.S. (Westford, MA; Ft. Davis, TX; and Owens Valley, CA) and Europe (Onsala, Sweden; Bonn, Federal Republic of Germany; and Chilbolton, England); these measurements had a precision of ±3 cm (Figure 3). The global laser network (Figure 4) operated throughout the year for repeated measurements of baselines between sites in North America and the Pacific, Pacific and South America, Pacific and Australia, North America and South America, and North America and Europe. Regular determinations of five-day values of polar motion and length of day were also made.

The Polaris station at Westford, MA, was completed by NASA, under contract to NOAA, and was accepted by NOAA in September 1983. By mid-year, Polaris (Figure 5) started routine measurements of polar motion and UT using two stations. The results to date have repeatability of 2 milli-arcseconds in polar motion and 70 microseconds in UT1.

Laser ranging data using Lageos has been acquired from a dozen or more stations in the U.S. and abroad almost continuously since early 1976. Polar motion measurements derived from these data for the period of May 1976 to August 1981 (Figure 6) show the damping of the Chandler wobble during the past few years.

The Project continued lunar laser ranging measurements of the length of day using the 107" telescope at McDonald Observatory (Fort Davis, TX). Very good agreement was demonstrated between polar motion determinations from VLBI, satellite laser ranging and lunar ranging. Significant differences from BIH were found.

B. INVESTIGATIONS

In response to the NASA Announcement of Opportunity for Crustal Dynamics and Earthquake Research, 57 investigations were selected to use data acquired by the CDP. These investigations include research in regional crustal deformation, plate motion, earth rotational dynamics, and system performance evaluation and improvement. A list of the approved investigators, their affiliation, and a brief title of the investigation is included as Appendix 1.

At the first meeting of the selected investigators in September 1981, discussions were initiated of specific measurement sites in the U.S., Caribbean, Alaska, and Europe. This discussion was continued through a series of meetings in 1981 to resolve experiment differences and to confirm a set of mutually acceptable sites.

C. VLBI SYSTEM DEVELOPMENT

In 1981, MV-1 and MV-2 antenna and associated electronics vans were equipped with a Mark-III data system. These systems, operating in conjunction with compatible base stations at Owens Valley Radio Observatory, Goldstone, and Fort Davis (Texas) occupied a total of 14 sites in 1981.

The NASA STDN station at Mojave, California, was transferred to the CDP, and implementation of VLBI capability there was initiated. This station will be developed as a dedicated geodetic VLBI base station for western U.S. regional studies and will replace Project use of the DSS-13 antenna at Goldstone, CA.

Work continued in the development of MV-3, the first mobile VLBI system specifically designed for geodetic measurements. Both the Mojave station and the MV-3 are to be in operation in early 1983.

To improve the efficiency and use of VLBI, several R&D activities were conducted. These included:

(1) Studies of tape recording methods which would produce at least an order of magnitude improvement in bit density on the Mark-III data tapes which, in turn, will lead to a significant reduction in cost and logistics problems during data acquisition and correlation.

(2) Development of three-baseline correlation to reduce processing time.

(3) Development of analytic techniques involving baseline triangular closure. One technique uses simultaneous observations over a network of stations; if one baseline is weak due to the use of small antennas, the missing observations are inferred by instantaneous delay closure through larger "base" stations. These results showed that using this procedure there is no significant loss in performance, and that station site occupations might be saved by improved sensitivity. A related technique is to give one station two different names in the analysis; the covariance analysis results are tested by examining closure on the resulting zero-length baseline.

Improvements in VLBI analytic models were made. These included new formulations of the raw VLBI time-delay observable, with effects of special and general relativity. This analysis showed that in addition to terms in the existing models, gravitational bending of light by Jupiter should be incorporated for sources near the ecliptic, and that a refraction-like bending of light by the earth's gravitation field should be included.

The J2000 IAU and MERIT definitions were implemented into the GSFC CALC/SOLVE analysis software. The new formulations show 5-10 milliarcsecond repeatability between disjoint data sets.

Studies were also conducted of a radio reference frame for accurate measurement of baselines using VLBI. This study involves fitting 742 parameters for 1971-1980 VLBI data, including station location, solid earth tides, earth orientation, precession, source locations, clock offsets and rates, and properties of the troposphere. The rms residuals obtained were 0.3 psec/sec for delay rate and 0.5 nsec for delay.

Seven of the eight NASA water vapor radiometers (WVR) were installed at VLBI stations in 1981. The stations currently equipped with WVRs are Owens Valley, Goldstone, Fort Davis, Haystack/Westford, and the NASA MV-1 and MV-2 systems. Verification tests show that the WVRs are capable of making calibrations at the centimeter level; the most impressive results were obtained with WVRs on two antennas 7 km apart at the National Radio Astronomy Observatory's VLA facility in New Mexico, which measured interferometric phase fluctuations at the sub-centimeter level.

Studies of various effects on hydrogen maser frequency standards and the resultant propagation of errors into VLBI measurements show that improved analytic parameterization of clocks in terms of epoch, rate, and diurnal sinusoids improves the recovery of geodetic parameters. It was found that with good environmental control of the masers, systematic errors are significantly reduced, and post-fit residuals for the entire VLBI system are similar in behavior to laboratory measurements of the masers themselves.

While it is generally agreed that VLBI has demonstrated precision at better than three centimeters; and the thrust is now to improve system precision to the one-centimeter level, results of detailed analysis of residual instrumental effects and ionospheric calibrations show that the formal standard errors based on multiparameter covariance analysis should be scaled upward by factors of 2-3 to account for non-random error sources.

Results of studies of ionospheric effects indicate that if only X-band (8.4 GHz) data are used at times of solar maximum, errors up to 20 cm in baseline length on long baselines could result. Similar results from the mobile VLBI systems on short baselines showed that S-band (2.3 GHz) daytime data was seriously corrupted by the ionosphere and should not presently be used for geodetic analysis. However, nighttime S-band data, as well as X-band data for both day and night, can probably be trusted at the 5-10 cm level on baselines up to 400 km.

D. LASER SYSTEM DEVELOPMENT

In 1981, Moblas-7 (with an upgraded Sylvania laser) replaced the aging Stalas in the GSFC laser tracking network. Moblas stations were established at Platteville, CO; Monument Peak, CA; and at a new location at Quincy, CA. The satellite laser ranging capability at Haleakala, HI, was improved, and after extensive collocation with Moblas-1 (which demonstrated the high precision of the improved system), the station was returned to operational status.

The TLRS-1 was placed into operation in early 1981. The first year of tracking with TLRS-1 showed good nighttime tracking of Lageos, but the daytime tracking capabilities of TLRS-1 need to be improved. Three items are being incorporated to improve daytime tracking: (a) better on-site integration; (b) installation of an 0.8 micron Fabry-Perot interference filter; and (c) software upgrading.

Work continued at GSFC on the development of TLRS-2, which is to be completed in 1982 and deployed to Easter Island in the Pacific. A Quantel laser has been obtained for this system.

In 1981, sub-centimeter precision ranging with a Quantel laser and an ITT detector was demonstrated using Moblas-4. Based on the test results, the Quantel laser has been selected for the upgrading of Moblas 5-8. Procurement for four additional Quantel lasers has been implemented. Work was also initiated in 1981 to improve the

SAO laser ranging systems, and studies of associated hardware improvements needed to enhance these lasers were continued. The upgrading was carried out at Mt. Hopkins, AZ, and will improve the range accuracy from 10 to 5 cm, increase the Lageos data rate from 8 to 30 ppm, and improve the daytime Lageos tracking capability. Initial tests show that the wavefront distribution is still a problem that must be solved before the system can be implemented. In 1982, it is planned to retrofit the SAO laser at Arequipa, Peru. Because of funding reductions, the operations of the SAO laser at Natal, Brazil, were terminated in October 1981. This laser will be retrofitted and given on indefinite loan to the Italian CNR. In February 1982, operation of the SAO laser at Orroral Valley, Australia, was also terminated because of funding limitations.

The McDonald Lunar Ranging Station (MLRS) was designed to range to both Lageos and the moon. This station, which is to replace the use of the 107" telescope in the McDonald Observatory, neared completion in 1981. Actual testing is planned to begin in early 1982.

In a related activity, contract negotiations were initiated between NASA and the National Mapping Division (Natmap) of the Australian Department of National Development and Energy for the modification and upgrade of the Lunar Laser Ranging Station at Orroral Valley, Australia. This station, which was provided by NASA to Natmap on an indefinite loan basis in 1974, is to be modified to range to Lageos (with 1.5 cm precision) and the lunar ranging precision improved to ± 5 cm. The new Natmap Laser Ranging Station (NLRS) is expected to be operational in late 1983 or early 1984.

Analysis by the University of Texas of the quantity and quality of the laser ranging data taken during the past few years shows that not enough worldwide data is being obtained to adequately determine the model parameters necessary for good orbit determination. In particular, there are large gaps in the data taken from Europe. As far as the quality of the data is concerned, the study indicated large diurnal variations. Investigations are underway to find the source of these anomalies.

E. SYSTEM VALIDATION AND INTERCOMPARISON

Intercomparison of VLBI systems with geodetically determined baselines were conducted in the late 1970's. These intercomparisons were later extended to include VLBI and laser systems (see NASA, 1980, and NASA, 1981, for historical accounts).

Intercomparison Session IV (October 1979 - March 1980) involved Moblas and VLBI stations at Westford, Fort Davis, Goldstone, and Owens Valley; Intercomparison Session V (October - December 1980) involved JPL, Owens Valley, and Goldstone. Baselines were determined independently by satellite laser ranging and VLBI. The baselines were compared between common points located at each site. The differences between SLR and VLBI measurements of seven baselines were found to average about 7±3 cm (Figure 7).

F. DATA BASE

The CDP has established a data base system (NASA, 1981b) which will provide for ready access of investigators and other users of the data acquired by the CDP. Several types of information will be available to users in 1983 via remote terminals; these include the data sets provided by the SLR and VLBI Crustal Dynamics support groups, which include station coordinates, baseline lengths, polar motion, and length of day.

V. RESEARCH STATUS AND RESULTS

Additional results of research being conducted in the Geodynamics Program are described elsewhere in this report. In this section we summarize results presented at the Fourth Annual Conference on the NASA Geodynamics Program held at Goddard Space Flight Center in January 1982.

A. GLOBAL EARTH STRUCTURE AND DYNAMICS

Investigators are studying polar motion and earth rotation using data acquired by the Crustal Dynamics Project. VLBI determinations between observatories in the United States and Europe yielded baseline accuracies of 2-3 cm, polar motion to 2-3 milli-arcseconds, and UT1 to 20 microseconds during the MERIT short campaign in 1980. Differences between polar motion by VLBI and the BIH values amount to 4-9 m.

Several groups are studying the relationship between earth rotation rate and atmospheric angular momentum. Coupling between the solid earth and the oceans is being studied by Dickman in an attempt to explain the modulation of the Chandler wobble. Slade and others are studying the excitation of Chandler wobble by earthquakes, using a three-dimensional finite element program.

Gravitational and hydromagnetic coupling between the inner core, the outer core, and the mantle are being studied by Yoder. The torques caused by these types of coupling can affect the variation of the obliquity of the ecliptic and the 18.6 year forced nutation. Yoder proposes a highly deformable inner core to explain his observations. Kaula, Jarvis, Daly, and others are working on numerical studies of mantle convection.

Geophysical studies are being made using satellite-derived gravity field, geoid, and altimetry measurements. B. Marsh has shown that intermediate-wavelength gravity anomalies in the Pacific are explained by lithospheric structure, and that mantle effects are confined to low degree and order. Isostatically compensated topography can affect interpretation of geoid anomalies; Jones showed that the previous discrepancy between observed and calculated geoid anomalies in subduction zones can be explained on this basis. Hager and McAdoo have shown that internal flow and induced surface depression must be taken into account in calculating theoretical geoid anomalies. Different lithospheric cooling models can be discriminated using relationships between observed geoid height and crustal age; Sandwell is studying oceanic fracture zones from this point of view. Geoid anomalies are also being used by Roufosse to constrain models of lithospheric evolution and by A. J. Anderson to study crustal structure in Fennoscandia.

B. CRUSTAL MOTION AND REGIONAL CRUSTAL DEFORMATION MODELING

Global Lageos data and VLBI observations in the United States and between the U.S. and Europe do not yet show inter-station movements significantly different from zero. Mobile VLBI and laser ranging station measurements in California have also not yet detected crustal movements, although the correlation between apparent changes of VLBI station position and changes detected by ground-based geodetic measurements argue against systematic biases. Geodetic measurements in the Imperial Valley predict measurable crustal movements in that area, mainly across the southward extension of the San Andreas Fault System. Time-dependent post-seismic deformation, deformation at transform plate boundaries, intraplate deformation and stress, and intracrustal damping of geodetic displacements are being studied by several groups.

C. GEOPOTENTIAL FIELD MODELS

Two new gravity field models have been developed. One is Goddard Earth Model L1 (GEM-L1), which was developed by Lerch to improve Lageos orbit calculations and for use in long-wavelength sea-surface topography studies. The model has improved Lageos orbit errors from 1 meter to better than 50 cm; in calculating the field model, polar motion was also determined with an estimated precision of 8 cm. The other model is a 36x36 harmonic model derived by Reigber from surface gravity, satellite orbit perturbations, and GEOS-3 altimetry. These models differ in the nature and extent of mixing the similar gravity input parameters.

The Goddard Geodynamics Program (GEODYN) is being modified by Putney to adapt it to the new Cyber-205 computer at GSFC. The new machine is ten times the speed of the present IBM 360/95 system, and processes in a vector mode.

A magnetic field model, based entirely on Magsat data, has been adopted as the 1980 International Geomagnetic Reference Field (IGRF) by IAGA. Temporal variation analysis of magnetic observatory data were improved by Langel, by adding cubic terms to their variation. Initial maps of the vector components of the crustal magnetic field were derived by Langel from the Magsat data. These are shown in Figures 8a, 8b, and 8c for the Z component (vertical), the X component (north), and the Y component (east), respectively.

Detailed interpretations by Coles of Magsat data at high northern latitudes have shown convincing comparisons between the magnetic anomalies and large geological features in Canada. Crustal magnetic anomalies are being studied by Frey, who is interested in their correlation with global geological features, and in matching anomalies across continental boundaries. Syntheses of satellite gravity, magnetic, and imaging data, together with ground-based geophysical and geological data, are being used by Qureshy to study the structure of the Indian subcontinent and by Lavin and Alexander to study crustal structure in the eastern United States.

VI. ADVANCED STUDIES AND MISSIONS

Activities in this area are concentrated in three areas: methods of improvement of gravity and magnetic field measurements, development of capability for making rapid geodetic surveys of local deformation, and precise time transfer over intercontinental distances.

A. GRAVITY AND MAGNETIC FIELD MEASUREMENTS

The major effort has been design studies for the Geopotential Research Mission (GRM). The mission objectives are to produce global magnetic field models with an accuracy of 2nT in magnetic field magnitude (5nT in each component) and gravity field models with an accuracy of about 1 mgal; the horizontal resolution will be about 100 km for both types of measurement. The gravity field from GRM will provide nearly an order of magnitude improvement over current models for wavelengths from 100 to 1500 km. The magnetic field model will be an improvement of a factor of 4 over that produced by Magsat, and the second vector survey will be used to study secular variation of the geomagnetic field.

The GRM mission (Figure 9) will use measurement of relative acceleration between two spacecraft in 160 km orbit, 300 km apart, to determine the gravity field and Magsat instrumentation to make the magnetic measurements. Drag compensation will be done by sensing the position of a small proof mass in a cavity in each spacecraft and activating thrusters to maintain the mass in the center of the cavity. The relative velocity of the spacecraft must be measured to the order of one micron/second; in laboratory breadboard systems the range-rate system noise performance was found to be about 0.3 micron/second for four-second averaging times. Detailed simulations have been performed on the guidance and control systems.

Development of a cryogenic gravity gradiometer, which is a candidate for a post-GRM gravity field mapping mission, is continuing. The instrument appears to have the potential for improvement in resolution by a factor of 2 and in accuracy by a factor of 10 beyond that achievable by GRM. The instrument is an accelerometer consisting of a superconducting proof mass confined to move along a single axis, and a superconducting sensing coil located near the proof mass surface and connected to a SQUID. By differencing the outputs of the accelerometer pairs it is possible to measure the inline and cross components of the gravity tensor simultaneously. The expected sensitivity is better than 0.001 Eötvös/Hz$^{1/2}$. A single-axis laboratory prototype unit has been constructed and is being tested (Figure 10).

B. RAPID SURVEYS FOR LOCAL DEFORMATION

An Airborne Laser Ranging System (ALRS) is being studied, in which a laser mounted in an aircraft would be used to range to a grid of cube corner reflectors on the ground. Six-legged range measurements are made. Simulations have been made for a region 14 by 112 km, with reflector grid spacing of 7 km. With aircraft altitudes of 3.9 and 6.0 km, and assuming that meteorological information is available with an accuracy of 1 millibar, the distance between points 100 km apart could be determined in one day with a standard error of about 1.5 cm.

Another method for local surveying uses radio signals from the Global Positioning System satellites. NASA is supporting development of the SERIES system (Satellite Emission Range Inferred Earth Surveying). A pair of prototype stations are being constructed and will be tested in 1982 over baselines of 150m and 22km. Three-dimensional baseline accuracies of 0.5 to 3 cm over distances of 2 to 200 km are expected, with about ten minutes of on-site data acquisition time.

C. TIME TRANSFER

An experiment on the ESA SIRIO-2, Laser Synchronization from Stationary Orbit (LASSO), mission will use ground-based lasers which fire pulses at predicted times toward the geosynchronous SIRIO-2 spacecraft. Measurement of the two-way travel times will be used to establish the relative difference in time at the ground stations. A Shuttle time and frequency transfer experiment is also under study, in which the Shuttle would carry a hydrogen maser clock; transfer would be accomplished via a three-way microwave doppler system, and the clock could be interrogated by laser pulses from ground stations. Such a system would provide time transfer at the subnanosecond level and frequency synchronization to one part in 10^{14} per day.

TABLE 1

Geodynamics Program Funding FY 1980-1983

(in millions)

	FY80	FY81	FY82	FY83*
Crustal Dynamics Project	$9.6	$11.6	$14.0	$16.5
Laser Network Operations	10.8	10.9	6.5	7.0
Research and Technique Development	3.0	3.2	2.2	2.7
Magsat Mission	1.6	0.5	0.3	0.1
GRM Studies	0.3	0.9	0.7	0.5
Total	25.3	27.1	23.7	26.6

*Planned

APPENDIX 1

CRUSTAL DYNAMICS PROJECT INVESTIGATORS AND INVESTIGATIONS

Aardoom, L. (Delft University of Technology, Delft, The Netherlands): Development of SLR Techniques and their Application for Measuring Crustal Motion in Europe.

Agnew, D. C. (Scripps Institute of Oceanography, La Jolla, California): Application of Statistical Time Series Analysis Methods to the Study of Irregularities in Regional Crustal Deformation.

Anderson, A. J. (University of Uppsala, Sweden): Crustal Movements in Scandinavia using VLBI.

Ashkenazi, V. (University of Nottingham, England): Simultaneous Adjustment of Spatial and Terrestrial Geodetic Data.

Barlier, F. (CERGA/GRGS, Toulouse, France): SLR Techniques for Crustal Dynamics.

Bender, P. L. (National Bureau of Standards, University of Colorado, Boulder, Colorado): Analyzing the Accuracy of Reliability of Lageos-determined Baselines.

Bird, G. P. (University of California, Los Angeles, California): Testing Models of Crustal Flow and Fault Slip in California.

Boucher, C. (GRGS/IGN, Toulouse, France): VLBI Techniques for Crustal Dynamics.

Calame, O. (CERGA/GRGS, Grasse, France): Study of Earth-Moon System by Lunar Laser Data Analysis.

Calderon R., Gustavo (Instituto Oceanografico, Mexico): Geodetic Studies of the Gulf of California Region.

Clark, T. A. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Development of Observatory VLBI Techniques to Measure Contemporary Tectonic Plate Motion.

Dewey, J. F. (State University of New York, Albany, New York): Tectonic Studies of the Turkish East Anatolian Convergent Zone and Surrounding Areas by Field Studies, Landsat Imagery, and SLR and VLBI Data.

Fanselow, J. L. (Jet Propulsion Laboratory, Pasadena, California): Determination of Accurate Baselines and Empirical Strain Models from Mobile VLBI Data in the Western U.S.

Hager, B. H. (California Institute of Technology, Pasadena, California): Stress in the Lithosphere and the Driving Mechanisms for Plate Motions.

Jackson, D. D. (University of California, Los Angeles, California): Horizontal Tectonic Displacements in Southern California.

Johnson, T. (Lamont-Doherty Geological Observatory, Palisades, New York): Determination of Internal Deformation in Alaska and Pacific-North American Relative Plate Motion.

Johnston, K. J. (Naval Research Laboratory, Washington, DC): Measurement of Baselines to High Precision Using VLBI.

Jordan, T. H. (Scripps Institution of Oceanography, La Jolla, California): Predictions of the Motion of Project Sites, Comparisons with Observed Motions, and Development of New Numerical Models of Plate Motion.

Kahle, H.-G. (Institut für Geodesie and Photogrammetrie, Zürich, Switzerland): Geodynamic Processes in the Alpine Region.

Kausel, E. (Universidad de Chile, Santiago, Chile): Relative Motion of the Nazca and South America Plates, and Crustal Deformation in the Andes.

Kolenkiewicz, R. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Determination of Baselines Between SLR Sites in the Western U.S. from Lageos and BE-C Data.

Lago, B. (CNES/GRGS, Toulouse, France): Geophysical Interpretation of Spatial Geodetic Data.

Lambert, A. (Dept. of Energy, Mines and Resources, Ottawa, Canada): North American Plate Deformation in Canada.

Lerch, F. J. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Gravity Model Improvement from Lageos Data.

Lopez Arroyo, A. (Instituto Geografico Nacional, Madrid, Spain): Application of Geophysical, Geodetic, and Space Techniques to the Study of Crustal Dynamics and Seismicity in the Western Mediterranean.

Lyzenga, G. A. (Jet Propulsion Laboratory, Pasadena, California): Finite Element Modeling of Regional Strain and Crustal Deformation in California.

Marsh, J. G. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Determining the Center of Mass Coordinates of the Global Laser Ranging Stations to an Accuracy of 5 cm.

McCarthy, D. D. (U.S. Naval Observatory, Washington, DC): Rapid Determination of PM/UT.

Minster, J.-B. (Systems, Science, and Software, La Jolla, California): Predictions of the Motion of Project Sites, Comparisons with Observed Motions, and Development of New Numerical Models of Plate Motion.

Morgan, W. J. (Princeton University, New Jersey): Polar Motion and Variations in Earth Rotation and their Correlation with Other Geophysical Phenomena; Plate Rigidity and Plate Motion.

Ness, G. (Oregon State University): Geodetic Studies of the Gulf of California Region.

O'Connell, R. J. (Harvard University, Cambridge, Massachusetts): Large-scale Deformation of the Lithosphere and Smaller-scale Regional Lithospheric Deformation in the Western U.S.; Excitation of the Polar Wobble by Seismic and Aseismic Events.

Oliver, J. E. (Cornell University, Ithaca, New York): Regional Deformation at Plate Boundaries in Southern California and Alaska; Internal Deformation of the North American Plate.

Rogers, A. E. E. (Haystack Observatory/NEROC, Westford, Massachusetts): Development of High Precision VLBI Techniques to Achieve a 3-sigma Accuracy in Baseline Length Determination of Less Than 1 cm.

Rosen, R. D. (Atmospheric and Environmental Research, Inc., Cambridge, Massachusetts): Atmospheric Excitation of Changes in Earth Rotation and Polar Motion.

Rundle, J. B. (Sandia National Laboratory, Albuquerque, New Mexico): Regional Strain Accumulation Models in Southern California; Determination of Material Properties of the Lithosphere at Depth.

Ryan, J. W. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Intercomparison of Baselines Determined by both SLR and VLBI Techniques.

Scholz, C. H. (Lamont-Doherty Geological Observatory, Palisades, New York): Tectonic Studies in California; Interpretation of Crustal Motions Along the San Andreas Fault.

Shaffer, D. B. (Phoenix Corporation, McLean, Virginia): Improving the VLBI Reference Frame Through Development of an Improved Catalog of Compact Radio Sources.

Shapiro, I. I. (Massachusetts Institute of Technology, Cambridge, Massachusetts): VLBI Techniques for Reliable Determination of the Motion and Deformation of North American and Eurasian Plates.

Shapiro, I. I. (Massachusetts Institute of Technology, Cambridge, Massachusetts): Determination of UT, Polar Motion, Nutation, GM Earth, and Solid Earth Tides Through Analysis of Lunar Laser Data.

Shelus, P. J. (University of Texas, Austin, Texas): Earth Rotation and Polar Motion Parameters from Lunar Laser and Lageos Data.

Smith, D. E. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Determination of the Positions and Relative Motions of All the Fixed and Mobile Laser Ranging Stations.

Solomon, S. C. (Massachusetts Institute of Technology, Cambridge, Massachusetts): Studies of Plate Driving Forces; Mechanical Properties of the Lithosphere and Asthenosphere.

Stein, S. (Northwestern University, Evanston, Illinois): Studies of Regional Deformation in the Great Basin Area of the Western U.S., and Within Oceanic Plates.

Stolz, A. (University of New South Wales, Sydney, NSW, Australia): SLR Measurements in Australia.

Stolz, A. (University of New South Wales, Sydney, NSW, Australia): VLBI Measurements in Australia.

Tapley, B. D. (University of Texas, Austin, Texas): Technique Development for the Analysis of SLR Data to Obtain TLRS Coordinates, SLR Network Coordinates, Global Baselines, Polar Motion, Length of Day, and UT1; Interpretation in Terms of Geophysical Signal and Characteristics of Error Sources Associated with SLR Techniques.

Torge, W. (Universität Hannover, West Germany): High-precision Gravity Network in the Aegean Region.

Turcotte, D. L. (Cornell University, Ithaca, New York): Models of Strain Accumulation and Stress Release Adjacent to the San Andreas Fault.

Walcott, R. I. (Dept. of Scientific and Industrial Research, Wellington, New Zealand): Crustal Deformation Measurements in New Zealand.

Whitcomb, J. H. (CIRES, University of Colorado, Boulder, Colorado): Correlation of Project-acquired Data in the Western U.S. with Other Geophysical Parameters (Gravity, Seismic, Radon).

Williams, J. G. (Jet Propulsion Laboratory, Pasadena, California): Determination of GM Earth, Coordinates of Lunar Laser Stations and the Phase of the M2 Tide from LLR Data; Modeling the Earth-Moon System at the 3-5 cm Level.

Wilson, P. (Institut für Angewandte Geodäsie, Frankfurt, West Germany): Development of SLR and VLBI Techniques to Measure Crustal Motion in the Eastern Mediterranean.

Wyss, M. (CIRES, University of Colorado, Boulder, Colorado): Tectonics of the Aegean and Surrounding Areas.

Ye Shu-Hua (Shanghai Observatory, Shanghai, People's Republic of China): Development of Space Geodetic Techniques in China.

Yoder, C. F. (Jet Propulsion Laboratory, Pasadena, California): Geophysical Sources of Variable Earth Rotation.

APPENDIX 2

Investigations Selected In Response to the Applications Notice, 1981

Berger, J. (University of California, La Jolla, California): Precision Measurement of Benchmark and Monument Displacements for Use in Crustal Dynamics Studies.

Cohen, S. C. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Models of Coseismic and Postseismic Deformation.

Counselman, C. C. (Massachusetts Institute of Technology, Cambridge, Massachusetts): Very Long Baseline Interferometry with GPS Satellites.

Crough, S. T. (Purdue University, West Lafayette, Indiana): Geoid Height and the Thickness of the Lithosphere.

Daly, S. (Jet Propulsion Laboratory, Pasadena, California): Mantle Convection with Variable Properties.

Dickman, S. R. (State University of New York, Binghampton, New York); Further Investigation into Effects of the Oceans on Polar Motion.

Felsentreger, T. L. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Estimation of Solid Earth/Ocean Tidal Parameters from Satellite Tracking Data.

Frey, H. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Satellite Geopotential Anomalies: Global Distribution and Relation to Surface Data.

Frey, H. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Age of Satellite-Observed Magnetic and Gravity Anomalies Using Paleo-Reconstructions.

Jones, G. M. (Texas A&M University, Bryan, Texas): Altimetry Data and the Deep Structure of Subduction Zones.

Kaula, W. M. (University of California, Los Angeles, California): Earth Dynamics Analyses.

Lowman, P. D. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Late Cenozoic Tectonics of the Basin and Range Province and the San Andreas Fault System.

Marsh, B. D. (Johns Hopkins University, Baltimore, Maryland): Delineation and Interpretation of the Earth's Gravity Field.

McAdoo, D. C. (NASA Goddard Space Flight Center, Greenbelt, Maryland): Dynamic Processes of Convergent Plate Margins.

Molnar, P. (Massachusetts Institute of Technology, Cambridge, Massachusetts): Study of Seismic Wave Velocity Structure in the Downgoing Slab and the Olivine-Spinel Phase Change.

Molnar, P. (Massachusetts Institute of Technology, Cambridge, Massachusetts): Seismicity and Active Tectonics of the Andes and the Origin of the Altiplano.

Mueller, I. I. (Ohio State University, Columbus, Ohio): Intercomparison of Different Space Geodetic Measurement and Computational Techniques for the Establishment of a Terrestrial Reference Coordinate System for Earth Dynamics.

Nur, A. (Stanford University, Stanford, California): Models for Rupture Mechanics of Plate Boundaries and Crustal Deformation.

Rapp, R. H. (Ohio State University, Columbus, Ohio): Improvement of the Earth's Gravity Field from Terrestrial and Satellite Data.

Roufosse, M. C. (Smithsonian Astrophysical Observatory, Cambridge, Massachusetts): Global Study of the Time Evolution of the Lithosphere Using GEOS-3 and Seasat Radar Altimeter.

Roman, N. G. (ORI, Inc., Greenbelt, Maryland): Critical Review of the Use of VLBI for Geodesy.

Schubert, G. (University of California, Los Angeles, California): Thermal Isostasy in the World's Oceans.

Solomon, S. C. (Massachusetts Institute of Technology, Cambridge, Massachusetts): Application of Laser Ranging and VLBI Data to a Study of Plate Tectonic Driving Forces.

Toksöz, M. N. (Massachusetts Institute of Technology, Cambridge, Massachusetts): Geophysical Study of the Structure and Processes of Continental Convergence Zones of the Alpine-Himalayan Belt.

Wu, F. T. (State University of New York, Binghampton, New York); Crustal Dynamics Studies in The People's Republic of China.

Whitcomb, J. H. (CIRES, University of Colorado, Boulder, Colorado): Modeling of Tectonophysical Distortion from Measurements of Long Baseline Geodetic Data and Other Geophysical Parameters.

APPENDIX 3

Glossary of Acronyms and Abbreviations

ALRS	Airborne Laser Ranging System
AN	Applications Notice
AO	Announcement of Opportunity
BIH	Bureau International de l'Heure
CNES	Centre National d'Etudes Spatiales (France)
CNR	Consiglio Nazionale delle Recerche (Italy)
CDP	Crustal Dynamics Project
CSTG	Commission on International Coordination of Space Techniques for Geodesy and Geodynamics
DMA	Defense Mapping Agency
DOC	Department of Commerce
DOD	Department of Defense
DSN	Deep Space Network
DSS	Deep Space Station
ESA	European Space Agency
FY	Fiscal Year
GEM	Goddard Earth Model
GEODYN	Goddard Computer Program for Geodynamics and Orbital Computations
GEOS	Geodynamic Experimental Ocean Satellite
GPS	Global Positioning System
GRM	Geopotential Research Mission
GSFC	Goddard Space Flight Center
GUWG	Gravsat User Working Group
HO	Haystack Observatory
HRAS	Harvard Radio Astronomy Station
IAG	International Association of Geodesy
IAGA	International Association of Geomagnetism and Aeronomy
IAU	International Astronomical Union
ICCG	Interagency Coordinating Committee for Geodynamics
ICSU	International Council of Scientific Unions
ICL	Inter-Union Commission on the Lithospehre
IGRF	International Geomagnetic Reference Field
ILP	International Lithosphere Program
IUGG	International Union of Geodesy and Geophysics
IUGS	International Union of Geological Sciences
JHD	Japanese Hydrographic Department
JPL	Jet Propulsion Laboratory
Lageos	Laser Geodynamics Satellite
LASSO	Laser Synchronization from Stationary Orbit
LLR	Lunar Laser Ranging
LURE	Lunar Ranging Experiment
Magsat	Magnetic Field Satellite
Mark-III	Advanced VLBI Data System
MERIT	Monitoring Earth Rotation and Inter-comparison of Techniques
MLRS	McDonald Laser Ranging Station

Moblas	Mobile Laser System
MSFC	Marshall Space Flight Center
MV	Mobile VLBI
NAS/NRC	National Academy of Sciences - National Research Council
NASA	National Aeronautics and Space Administration
Natmap	Division of National Mapping (Australia)
NBS	National Bureau of Standards
NCMM	National Crustal Motion Network
NGS	National Geodetic Survey
NEROC	Northeastern Radio Observatory Corporation
NGSP	National Geodetic Satellite Program
NLRS	Natmap Laser Ranging Station
NOAA	National Oceanic and Atmospheric Administration
NRAO	National Radio Astronomy Observatory
NSF	National Science Foundation
NSSDC	National Space Science Data Center
NSWC	Naval Surface Weapons Center
OSSA	Office of Space Science and Applications
OVRO	Owens Valley Radio Observatory
PM	Polar Motion
Polaris	Polar Motion Analysis by Radio Interferometric Systems
PRB	Program Review Board (Geodynamics)
RRL	Radio Research Laboratory (Japan)
RTD	Research and Technology Development
RTOP	Research and Technology Objectives and Plan
SAFE	San Andreas Fault Experiment
SAO	Smithsonian Astrophysical Observatory
SERIES	Satellite Emission Range Inferred Earth Surveying
SLR	Satellite Laser Ranging
Stalas	Stationary Laser System
STDN	Space Tracking and Data Network
TLRS	Transportable Laser Ranging Station
USGS	United States Geological Survey
USNO	United States Naval Observatory
VLA	Very Large Array
VLBI	Very Long Baseline Interferometry
UT	Universal Time
WVR	Water Vapor Radiometer

APPENDIX 4

PUBLICATIONS ON RESEARCH SUPPORTED BY THE NASA GEODYNAMICS PROGRAM

Araki, T., T. Iyemori, S. Tsunomura, T. Kamei, and H. Maeda, Detection of an Ionospheric Current for the Preliminary Impulse of the Geomagnetic Sudden Commencement. Geophys. Res. Lett. 9, 4, 341-344, 1982.

Archinal, B., and I. I. Mueller, A Comparison of Geodetic Doppler Satellite Receivers. Proc. Third International Geodetic Symposium on Satellite Doppler Positioning, 1982.

Aydin, A., and A. Nur, Evolution of Pull-apart Basins and their Scale Independence. Tectonics, in press, 1982.

Bender, P. L., Establishment of Terrestrial Reference Frames by New Observational Techniques. In Reference Coordinate Systems for Earth Dynamics, ed. E. M. Gaposchkin and B. Kolaczek, D. Reidel, Dordrecht, 23-36, 1981.

Benton, E. R., and M. C. Coulter, Frozen-Flux Upper Limits to the Magnitudes of Geomagnetic Gauss Coefficients, Based on Magsat Observations. Geophys. Res. Lett. 9, 4, 262-264, 1982.

Benton, E. R., R. H Estes, R. A. Langel, and L. A. Muth, Sensitivity of Selected Geomagnetic Properties to Truncation Level of Spherical Harmonic Expansions. Geophys. Res. Lett. 9, 4, 254-257, 1982.

Bergman, E. A., and S. C. Solomon, Intraplate Stress, in Encyclopedia of Structural Geology and Plate Tectonics, ed. C. K. Seyfert, Hutchinson Ross, Stroudsburg, Penna., 1982.

Bergman, E. A., and S. C. Solomon, Oceanic Intraplate Earthquakes and Stresses Near Large Bathymetric Features. E@S Trans. Amer. Geophys. Union 63, in press, 1982.

Brammer, R. F., R. V. Sailor, and A. R. Lazarewicz, Magsat Investigation of Lithospheric Magnetic Anomalies in the Eastern Indian Ocean. IAGA Bull. No. 45, 111, 1981.

Brown, R. D., W. D. Kahn, D. C. McAdoo, and W. E. Himwich, Roughness of the Marine Geoid from Seasat Altimetry. Submitted for publication, 1982.

Carle, H. M., and C. G. A. Harrison, A Problem in Representing the Core Magnetic Field of the Earth Using Spherical Harmonics. Geophys. Res. Lett. 9, 4, 265-268, 1982.

Chen, C. H., W. P. Chen, and P. Molnar, The Uppermost Mantle P-wave Velocities Beneath Turkey and Iran. Geophys. Res. Lett. 7, 77-80, 1980.

Chen, W. P., and P. Molnar, Constraints on the Seismic Wave Velocity Structure Beneath the Tibetan Plateau and their Tectonic Implications. J. Geophys. Res. 86, 5937-5962, 1981.

Chen, W. P., and P. Molnar, Constraints on the Seismic Wave Velocity Structure Beneath the Tibetan Plateau, in Proceedings of the Symposium on the Tibetan Plateau (in press), Beijing, 1982.

Cohen, S. C., Postseismic Rebound Due to Creep of the Lower Lithosphere and Asthenosphere. Geophys. Res. Lett. 8, 493-496, 1981.

Cohen, S. C., Relationships Among the Slopes of Lines Derived from Various Data Analysis Techniques and the Associated Correlation Coefficient. Geophysics 46, 1606, 1981.

Cohen, S. C., A multilayer Model of Time-dependent Deformation Following an Earthquake on a Strike-slip Fault. J. Geophys. Res., in press, 1982.

Cohen, S. C., and T. Peck, Reports on Crustal Movements and Deformations. NASA TM-83872, Goddard Space Flight Center, Greenbelt, Maryland, 1981.

Coles, R. L., G. V. Haines, G. Jansen van Beek, A. Nandi, and J. K. Walker, Magnetic Anomaly Maps From 40° N to 83° N Derived from Magsat Satellite Data. Geophys. Res. Lett. 9, 4, 281-284, 1982.

Colombo, O. L., Global Geopotential Modeling from Satellite-to-Satellite Tracking. Ohio State Univ. Dept. Geodetic Science Rept. 317, 1981.

Counselman, C. C., and S. A. Gourevitch, Miniature Interferometer Terminals for Earth Surveying: Ambiguity and Multipath with Global Positioning System. IEEE Trans. Geoscience and Remote Sensing GE-19, 244-252, 1981.

Counselman, C. C., and 8 others, Accuracy of Baseline Determinations by Mites Assessed by Comparison with Tape, Theodolite, and Geodimeter Measurements. EOS 62, 17, 260, 1981.

Counselman, C. C., and ten others, Accuracy of Relative Positioning by Interferometry with GPS: Double-blind Test Results. Proc. Third Internat. Symposium on Satellite Doppler Positioning, 1982.

Dalmayrac, B., and P. Molnar, Parallel Thrust and Normal Faulting in Peru and Constraints on the State of Stress. Earth and Planetary Science Lett. 55, 473-481, 1981.

Dickey, J. O., H. F. Fliegel, and J. G. Williams, Universal Time, UT1, from Lunar Laser Ranging Observations. BIH Annual Report, 1981.

Dickey, J. O., H. F. Fliegel, and J. G. Williams, Comparison of Polar Motion Results Using Lunar Laser Ranging, in IAU Colloq. 63, High-Precision Earth Rotation and Earth-Moon Dynamics: Lunar Distances and Related Observations, ed. O. Calame, D. Reidel, 1982.

Dickey, J. O., J. G. Williams, and C. F. Yoder, Results from Lunar Laser Ranging Data Analysis, in IAU Colloq. 63, High-Precision Earth Rotation and Earth-Moon Dynamics: Lunar Distances and Related Observations, ed. O. Calame, D. Reidel, 1982.

Dickman, Steven R., The Rotation of the Ocean-Solid Earth System. J. Geophys. Res., in press, 1982.

Ekkebus, E. J., Problems in Attaining Accurate State Estimates from an Extended Kalman Filter, Processing Laser Range-only Observations from a Single Tracking Station. Technical Thesis, Delft University of Technology, Dept. Aerospace Engineering, 1981.

Fliegel, H. F., J. O. Dickey, and J. G. Williams, Intercomparison of Lunar Laser and Traditional Determinations of Earth Rotation, in IAU Colloq. 63, High-Precision Earth Rotation and Earth-Moon Dynamics: Lunar Distances and Related Observations, ed. O. Calame, D. Reidel, 1982.

Frey, H., Magsat Scalar Anomalies and Major Tectonic Boundaries in Asia. Geophys. Res. Lett. 9, 4, 299-302, 1982.

Frey, H., Magsat Scalar Anomaly Distribution: The Global Perspective. Geophys. Res. Lett. 9, 4, 277-280, 1982.

Galliher, S. C., and M. A. Mayhew, On the Possibility of Detecting Large-Scale Crustal Remanent Magnetization With Magsat Vector Magnetic Anomaly Data. Geophys. Res. Lett. 9, 4, 325-328, 1982.

Hajela, D. P., A Simulation Study to Test the Prediction of 1° x 1° Mean Gravity Anomalies Using Least Squares Collocation from the Gravsat Mission. Ohio State Univ. Dept. Geodetic Science Rept. 316, 1981.

Hastings, D. A., Preliminary Correlations of Magsat Anomalies with Tectonic Features in Africa. Geophys. Res. Lett. 9, 4, 303-306, 1982.

Hermance, J. F., Model Simulations of Possible Electromagnetic Induction Effects at Magsat Activities. Geophys. Res. Lett. 9, 4, 373-376, 1982.

Herring, T. A., and 16 others, Determination of Tidal Parameters from VLBI Observations, in Proceedings of the Ninth International Symposium on Earth Tides, New York, 1981.

Herring, T. A., and 16 others, Geodesy by Radio Interferometry: Intercontinental Distance Determinations with Subdecimeter Precision. J. Geophys. Res. 86 B3, 1647-1651, 1981.

Herring, T. A., I. I. Shapiro, N. H. Bartel, B. E. Corey, A. E. E. Rogers, Geodesy by Radio Interferometry: Ionospheric Effects. EOS 62, 17, 620, 1981.

Hinze, W. J., R. R. B. Von Frese, M. B. Longacre, L. W. Braile, E. G. Lidiak, and G. R. Keller, Regional Magnetic and Gravity Anomalies of South America. Geophys. Res. Lett. 9, 4, 314-317, 1982.

Houseman, G. A., D. P. McKenzie, and P. Molnar, Convective Instability of a Thickened Boundary Layer and its Relevance for the Thermal Evolution of Continental Convergent Belts. J. Geophys. Res. 86, 6115-6132, 1981.

Hsui, A. T., B. D. Marsh, and M. N. Toksöz, On Melting of the Subducted Oceanic Crust: Effect on Subduction Induced Mantle Flow. Tectonophysics, in press, 1982.

Hsui, A. T., and M. N. Toksöz, The Evolution of Thermal Structures Beneath a Subduction Zone. Tectonophysics 60, 43-60, 1979.

Hsui, A. T., and M. N. Toksöz, Back Arc Spreading: Trench Migration, Continental Pull or Induced Convection. Tectonophysics 74, 89-98, 1981.

Hughes, T. J., D. D. Wallis, J. R. Burrows, and M. D. Wilson, Model Predictions of Magnetic Perturbations Observed by Magsat in Dawn-Dusk Orbit. Geophys. Res. Lett. 9, 4, 357-360, 1982.

Iijima, T., N. Fukushima, and R. Fujii, Transverse and Parallel Geomagnetic Perturbations Over the Polar Regions Observed by Magsat. Geophys. Res. Lett. 9, 4, 369-372, 1982.

Jones, G. M., A Technique for Computing Geoid Height Anomalies Over Two-dimensional Earth Models. Geophys. J. Roy. Astron. Soc., in press, 1982.

Jones, G. M., Isostatic Geoid Anomalies Over Trenches and Island Arcs. Geophys. J. Roy. Astron. Soc., submitted 1982.

Kaula, W. M., Problems in Understanding Vertical Movements and Earth Rheology. Earth Rheology, Isostasy, and Eustasy, N. A. Mörner, ed., John Wiley & Sons, Chichester, 577-588, 1980.

Kaula, W. M., Material Properties for Mantle Convection Consistent with Observed Surface Fields. J. Geophys. Res. 85, 7031-7044, 1980.

Kaula, W. M., Geodynamics from Satellites. *Advan. Astronaut. Sci. 41*, 627-631, 1980.

Kaula, W. M., The Next Development in Satellite Determination of the Earth's Gravity Field. *Proc. USA-Hungarian Workshop on Dynamics*, B. J. Balasz, Ed., Eötvos Univ., Budapest, 1982.

Kaula, W. M., Minimal Upper Mantle Temperature Variations Consistent with Observed Heat Flow and Plate Velocities. *J. Geophys. Res.*, submitted 1982.

Kaula, W. M., Inference of Variations in the Gravity Field from Satellite-to-Satellite Range-rate. *J. Geophys. Res.*, submitted 1982.

Klosko, S. M., J. G. Marsh, F. J. Lerch, and R. G. Williamson, Gravity Model Improvement for Seasat. *J. Geophys. Res.*, in press, 1982.

Klumpar, D. M., and D. M. Greer, A Technique for Modeling the Magnetic Perturbations Produced by Field-Aligned Current Systems. *Geophys. Res. Lett. 9*, 4, 361-364, 1982.

Langel, R. A., The Magnetic Earth as Seen from Magsat, Initial Results. *Geophys. Res. Lett. 9*, 4, 239-242, 1982.

Langel, R. A., R. H. Estes, and G. D. Mead, *Some New Methods in Geomagnetic Field Modeling Applied to the 1960-1980 Epoch.* NASA Tech. Mem. 83868, 1981.

Langel, R. A., R. H. Estes, and G. D. Mead, Some New Methods in Geomagnetic Field Modeling Applied to the 1960-1980 Epoch. *J. Geomag. Geoelect.*, in press, 1982.

Langel, R. A., and R. H. Estes, A Geomagnetic Field Spectrum. *Geophys. Res. Lett.*, 1982.

Langel, R. A., G. Ousley, J. Berbert, J. Murphy, and M. Settle, The Magsat Mission. *Geophys. Res. Lett. 9*, 4, 243-245, 1982.

Langel, R. A., J. D. Phillips, and R. J. Horner, Initial Scalar Magnetic Anomaly Map from Magsat, *Geophys. Res. Lett. 9*, 4, 269-272, 1982.

Langel, R. A., C. C. Schnetzler, J. D. Phillips, and R. J. Horner, Initial Vector Magnetic Anomaly Map from Magsat, *Geophys. Res. Lett. 9*, 4, 273-276, 1982.

Langel, R. A., and L. Thorning, Satellite Magnetic Field Over the Naros Strait Region, in *Nares Strait: A Central Conflict in Plate Tectonics Studies of the Arctic*, ed. P. R. Dowes and J. W. Ken: Medd. Grønland Geosci., 1982.

Langel, R. A., and L. Thorning, A Magnetic Anomaly Map of Greenland. *Geophys. J. Roy. Astron. Soc.*, in press, 1982.

Langley, R. B., R. W. King, and I. I. Shapiro, Earth Rotation from Lunar Laser Ranging. *J. Geophys. Res. 86,* 11913-11918, 1981.

Langley, R. B., R. W. King, I. I. Shapiro, R. D. Rosen, and D. A. Salstein, Atmospheric Angular Momentum and Length of Day: A Common Fluctuation with Period Near 50 Days. *Nature 294,* 730-732, 1981.

Langley, R. B., R. W. King, P. J. Morgan, and I. I. Shapiro, Rotation of the Earth from Lunar Laser Ranging, in *IAU Colloq. 63, High-Precision Earth Rotation and Earth-Moon Dynamics: Lunar Distances and Related Observations,* ed. O. Calame, D. Reidel, 1982.

Latimer, J. H., D. M. Hills, S. D. Vrtilek, A. Chaiken, D. A. Arnold, and M. R. Pearlman, An Evaluation and Upgrading of the SAO Prediction Technique. *Proc. Fourth International Workshop on Laser Ranging Instrumentation,* 1981.

Latimer, J. H., J. M. Thorp, D. R. Hanlon, and G. E. Gullahorn, A Review of Network Data Handling Procedures. *Proc. Fourth International Workshop on Laser Ranging Instrumentation,* 1981.

Liu, C. S., D. T. Sandwell, and J. R. Curray, The Negative Gravity Field Over the 85°E Ridge. *J. Geophys. Res.,* in press, 1982.

Longacre, M. B., W. J. Hinze, and R. R. B. von Frese, A Satellite Magnetic Model of Northeastern South American Aulacogens. *Geophys. Res. Lett. 9*, 4, 318-321, 1982.

Lowman, P. D., *A Global Tectonic Activity Map with Orbital Photographic Supplement.* NASA Tech. Mem. 82073, Greenbelt, Maryland, 1981.

Lowman, P. D., A Global Tectonic Activity Map. *Bull. Internat. Assoc. Engineering Geology 23,* 37-49, 1981.

Lowman, P. D., and H. V. Frey, *A Geophysical Atlas for Interpretation of Satellite-Derived Data.* NASA Tech. Mem. 79722, Greenbelt, Maryland, 1979.

Lowman, P. D., Crustal Evolution in Silicate Planets: Implications for the Origin of Continents. *J. Geol. 84,* 1-26, 1976.

Maeda, H., T. Iyemori, T. Araki, and T. Kamei, New Evidence of a Meridional Current System in the Equatorial Ionosphere. *Geophys. Res. Lett. 9*, 4, 337-340, 1982.

Marsh, J. G., R. E. Cheney. T. V. Martin, and J. J. McCarthy, Computation of a Precise Mean Sea Surface in the Eastern North Pacific Using SEASAT Altimetry. *EOS 63*, 9, 178-179, 1982.

Marsh, J. G., B. D. Marsh, R. G. Williamson, and W. T. Wells, The Gravity Field in the Central Pacific from Satellite-to-Satellite Tracking. *J. Geophys. Res. 86,* 3979-3997, 1981.

Marsh, J. G., and R. G. Williamson, Starlette Laser Data Analyses for Precision Orbit Determination. In press, 1982.

Mayhew, M. A., and S. C. Galliher, An Equivalent Layer Magnetization Model for the United States Derived from Magsat Data. Geophys. Res. Lett. 9, 4, 311-313, 1982.

McAdoo, D. C., On the Compensation of Geoid Anomalies Due to Subducting Slabs. NASA TM-82156, Goddard Space Flight Center, Greenbelt, Maryland, 1981.

McCarthy, D. D., An Intercomparison of Connected Element Interferometer and Lunar Laser Earth Rotation Parameters, in IAU Colloq. 63, High-Precision Earth Rotation and Earth-Moon Dynamics: Lunar Distances and Related Observations, ed. O. Calame, D. Reidel, 1982.

Mignard, F., Action de l'atmosphere Neutre et Ionisee Sur le Mouvement d'un Satellite - Application a Lageos. Ann. Geophys. 37, 247-252, 1981.

Molnar, P., and W. P. Chen, Constraints of the Amount of North-South Shortening in Tibet During the Cenozoic, in Proceedings of the Symposium on the Tibetan Plateau, in press, Beijing, 1982.

Molnar, P., and D. Gray, Subduction of Continental Lithosphere: Some Constraints and Uncertainties. Geology 7, 58-62, 1979.

Molnar, P., and P. Tapponnier, A Possible Dependence of Tectonic Strength on the Age of the Crust in Asia. Earth Planet. Sci. Lett. 52,107-114, 1981.

Morgan, P. J., and R. W. King, Determination of Coordinates for the Orroral Lunar Laser Ranging Station, in IAU Colloq. 63, High-Precision Earth Rotation and Earth-Moon Dynamics: Lunar Distances and Related Observations, ed. O. Calame, D. Reidel, 1982.

Mueller, I. I., Tecnicas Geodesicas Tridimensionales. J. Asociacion Salvadorena de Ingenieros y Arquitectos No. 61, p. 40-51; No. 62, p. 31-39, 1980.

Mueller, I. I., Space Geodetic Techniques and Geodynamics. Proc. First International Symposium on Crustal Movements in Africa, 1981.

Mueller, I. I., and B. Archinal, Geodesy and the Global Positioning System. Proc. IAG Symposium on Geodetic Networks and Computations, 1981.

Mueller, I. I., B. S. Rajal, and Y. S. Zhu, Comparison of polar Motion Data from the 1980 Project Merit Short Campaign. Proceedings IAU Colloq. 63 on High-Precision Earth Rotation and Earth-Moon Dynamics: Lunar Distances and Related Observations (Reidel), 1981.

Mueller, I. I., S.-Y. Zhu, & Y. Bock, Reference Frame Requirements and the MERIT Campaign - Proposal for Extra Observations. Dept. Geodetic Science and Surveying Report 329, Ohio State University, 1982.

Newitt, L. R., E. Dawson, R. L. Coles, and A. Nandi, Magnetic Charts of Canada Derived from Magsat Data. Geophys. Res. Lett. 9, 4, 246-249, 1982.

Pearlman, M. R., N. Lanham, J. Wohn, and J. Thorp, Current Status and Upgrading of the SAO Laser Ranging Systems. Proc. Fourth International Workshop on Laser Ranging Instrumentation, 1981.

Pearlman, M. R., Some Current Issues in Satellite Laser Ranging. Proc. Fourth International Workshop on Laser Ranging Instrumentation, 1981.

Pearlman, M. R., N. Lanham, J. Thorp, and J. Wohn, SAO Calibration Techniques. Proc. Fourth International Workshop on Laser Ranging Instrumentation, 1981.

Rapp, R. H., Ellipsoidal Corrections for Geoid Undulation Computations Using Gravity Anomalies in a Cap. J. Geophys. Res. 86, 10843-10848, 1981.

Rapp, R. H., Degree Variance of the Earth's Potential, Topography and its Isostatic Compensation. Bull. Geodesique, in press, 1982.

Reilinger, R. E., and J. Adams, Geodetic Evidence for Active Landward Tilting of the Oregon and Washington Coastal Ranges. geophys. res. lett.,, 9, 4, 401-403, 1982.

Reilinger, R. E., and L. D. Brown, Neotectonic Deformation, Near Surface Movements and Systematic Errors in U.S. Releveling Measurements: Implications for Earthquake Prediction, in Earth Prediction - An International Review, 422-440, eds. D. W. Simpson and P. G. Richards, Maurice Ewing Series #4, Amer. Geophys. Union, Washington, 1981.

Resch, G. M., Water vapor - the Wet Blanket of Microwave Interferometry, in Atmospheric Water Vapor, eds. Deepak, Wilkerson, and Ruhnke, Academic Press, New York, 1980.

Ritzwoller, M. H., and C. R. Bentley, Magsat Magnetic Anomalies Over Antarctica and the Surrounding Oceans. Geophys. Res. Lett. 9, 4, 285-288, 1982.

Roecker, S. W., Velocity structure of the Pamir-Hindu Kush region: Possible Evidence of Subducted Crust. J. Geophys. Res. 87, 945-959, 1982.

Rowlands, D., The Adjustment of Seasat Altimeter Data on a Global Basis for Geoid and Sea Surface Height Determinations. Ohio State Univ. Dept. Geodetic Science Rept. 325, 1981.

Rubincam, D. P., Information Theory Lateral Density Distribution for Earth Inferred from Global Gravity Field. NASA Tech. Mem. 83825, Greenbelt, Maryland, 1981.

Sailor, R. V., A. R. Lazarewicz, and R. F. Brammer, Spatial Resolution and Repeatability of Magsat Crustal Anomaly Data Over the Indian Ocean. Geophys. Res. Lett. 9, 4, 289-292, 1982.

Sandwell, D. T., and G. Schubert, Geoid Height Versus Age for Symmetric Spreading Ridges. J. Geophys. Res. 85, 7235-7241, 1980.

Sandwell, D. T., and G. Schubert, Geoid Height-Age Relation from Seasat Altimeter Profiles Across the Mendocino Fracture Zone. J. Geophys. Res., in press, 1982.

Sandwell, D. T., and G. Schubert, Lithospheric Flexure at Fracture Zones. J. Geophys. Res., in press, 1982.

Sandwell, D. T., and K. A. Poehls, A Compensation Mechanism for the Central Pacific. J. Geophys. Res. 85, 3751-3758, 1980.

Schilt, F. S., and R. E. Reilinger, Evidence for Contemporary Vertical Fault Displacement from Precise Leveling Near the New Madrid Seismic Zone, Western Kentucky. Bull. Seism. Soc. Amer. 71, 1933-1942, 1981.

Schmitz, D., J. B. Frayser, and J. C. Cain, Application of Dipole Modeling to Magnetic Anomalies. Geophys. Res. Lett. 9, 4, 307-310, 1982.

Schneeberger, R., D. Pavlis, and I. I. Mueller, Use of Simultaneous Doppler-Derived Ranges in the Geometric Mode. Proc. Third International Geodetic Symposium on Satellite Doppler Positioning, 1982.

Scholz, C. H., Scaling Laws for Large Earthquakes: Consequences for Physical Models. Bull. Seism. Soc. Amer. 72, 1-14, 1982.

Shapiro, I. I., Geodesy by Radio Interferometry: A Critical Review, in IEEE Digest, 1981 International Geoscience and Remote Sharing Symposium (IGARSS '81), 1, 206-217, 1981.

Suarez, G., Earthquake Mechanisms and the Depth of Faulting in the Central Andes. Earthquake Notes 52, 67, 1981.

Suzuki, A., and. N. Fukushima, Sunward or Anti-Sunward Electric Current in Space Below the Magsat Level. Geophys. Res. Lett. 9, 4, 345-348, 1982.

Taylor, P. T., A. F. Schanzle, T. L. Jones, R. A. Langel, and W. D. Kahn, Influence of Gravity Field Uncertainties on the Results from POGO and Magsat Geomagnetic Surveys, Geophys. Res. Lett. 12, 1246-1248, 1981.

Toksöz, M. N., W. R. Buck, and A. T. Hsui, Crustal Evolution and Thermal State of Tibet, in *Proceedings of the Symposium on the Tibetan Plateau*, in press, Beijing, 1982.

van Hulzen, J. J. P., *Kalman Filter Satellite Orbit Determination Using Single-Station Laser Ranging Observations.* Technical Thesis, Delft University of Technology, Dept. Aerospace Engineering, 1981.

Vermeer, M., *Kalman Filter Orbit Determination for Geodetic Satellite Laser Ranging; a Theoretical Inquiry.* Thesis, Delft University of Technology, Dept. Aerospace Engineering, 1981.

von Frese, R. R. B., W. J. Hinze, J. L. Sexton, and L. W. Braile, Verification of the Crustal Component in Satellite Magnetic Data. *Geophys. Res. Lett. 9*, 4, 293-295, 1982.

Voorhies, C. V., and E. R. Benton, Pole Strength of the Earth from Magsat and Magnetic Determination of the Core Radius. *Geophys. Res. Lett. 9*, 4, 258-261, 1982.

Wakker, K. F., B. A. C. Ambrosius, and J. J. P. van Hulzen, Kalman Filter Orbit Improvement from Kootwijk Laser Range Observations. *Adv. Space Res. 1*, 79-82, 1981.

Wakker, K. F., and B. A. C. Ambrosius, Kalman Filter Satellite Orbit Improvement Using Laser Range Measurements from a Single Tracking Station, in *Advances in Theory and Technology of Applications of Nonlinear Filters and Kalman Filters (AGARD)*, in press, 1982.

Wakker, K. F., and B. A. C. Ambrosius, *Accurate Orbit Determinations from Laser Ranging Observations of Lageos, Starlette, and Geos-3.* ESA SP-160, p. 25-35, 1981.

Wakker, K. F., and B. A. C. Ambrosius, *Some Results of Numerical Experiments on the Computation of the Kootwijk and Wettzell Satellite Laser Ranging Station Coordinates.* Delft University of Technology, Dept. Aerospace Engineering Memorandum M-409, 1981.

Wakker, K. F., B. A. C. Ambrosius, and T. van der Ploeg, *Preliminary Results of Seasat Orbit Determinations from Laser Range and European Doppler Observations.* Delft University of Technology, Dept. Aerospace Engineering Memorandum M-411, 1981.

Wallis, D. D., J. R. Burrows, T. J. Hughes, and M. D. Wilson, Eccentric Dipole Coordinates for Magsat Data Presentation and Analysis of External Current Effects. *Geophys. Res. Lett. 9*, 4, 353- 356, 1982.

Wasilewski, P., and D. M. Fountain, The Ivrea Zone as a Model for the Distribution of Magnetization in the Continental Crust. *Geophys. Res. Lett. 9*, 4, 333-336, 1982.

Wasilewski, P., and Mayhew, M. A., Crustal Xenolith Magnetic Properties and Long Wavelength Anomaly Source Requirements. Geophys. Res. Lett. 9, 4, 329-332, 1982.

Williams, J. G., Lunar and Planetary Ephemerides: Accuracy, Inertial Frames, and Zero Points. Proc. Fourth Internat. Workshop on Laser Ranging Instrumentation, 1981.

Williams, J. G., and W. G. Melbourne, Comments on the Effects of Adopting New Precessional and Equinox Corrections, in IAU Colloq. 63, High-Precision Earth Rotation and Earth-Moon Dynamics: Lunar Distances and Related Observations, ed. O. Calame, D. Reidel, 1982.

Won, I. J., and K. H. Son, A Preliminary Comparison of the Magsat Data in the Continental U.S. Geophys. Res. Lett. 9, 4, 296-298, 1982.

Wyatt, F. Distant Deformation for the Imperial Valley, California, Earthquake. Submitted to Bull. Seism. Soc. Amer., 1982.

Wyatt, F., Displacement of Surface Monuments: Horizontal Motion. J. Geophys. Res. 87, 979-989, 1982.

Wyatt, F., K. Beckstrom, and J. Berger, Optical Anchor - A Geophysical Strainmeter. Bull. Seism. Soc. Amer., submitted 1982.

Wyss, M., Some Earthquake Precursors and their Potential Use in the Balkans. Proc. Unesco Seminar on Earthquake Prediction and Instrumentation, Thessaloniki, 1981.

Wyss, M., and M. Baer, Earthquake Hazard in the Hellenic Arc. In Earthquake Prediction - An International Review, Maurice Ewing Series #4, Amer. Geophys. Union, Washington, 153, 172, 1982.

Yanagisawa, M., M. Kono, T. Yukutake, and N. Fukushima, Preliminary Interpretation of Magnetic Anomalies Over Japan and Its Surrounding Area. Geophys. Res. Lett. 9, 4, 322-324, 1982.

Yoder, C. F., and M. A. Slade, The free Librations of the Earth's Inner Core. Geophys. J. Roy. Astron. Soc., submitted, 1982.

Yoder, C. F., J. G. Williams, and M. E. Parke, Tidal Variations in Earth Rotation. J. Geophys. Res. 86, 881-891, 1981.

Yoder, C. F., J. G. Williams, M. E. Parke, and J. O. Dickey, Short-Period Variations in Earth Rotation. Annales de Geophysique 37, 213-217, 1981.

Zanetti, L. J., T. A. Potemra, and M. Sugiura, Elevation of High Latitude Disturbances with Magsat (The Importance of the Magsat Geomagnetic Field Model). Geophys. Res. Lett. 9, 4, 365-368, 1982.

Zanetti, L. J. , and T. A. Potemra, Correlated Birkeland Current Signatures From the Triad and Magsat Magnetic Field Data. Geophys. Res. Lett. 9, 4, 349-352, 1982.

Zhu, S.-Y., Prediction of Earth Rotation and Polar Motion. Dept. Geodetic Science and Surveying Report 320, Ohio State University, 1981.

REFERENCES

NASA, 1980: National Aeronautics and Space Administration, Geodynamics Program Office, Annual Report for 1979: NASA TM 81978, May 1980.

NASA, 1981a: National Aeronautics and Space Administration, Geodynamics Program Office, Annual Report for 1980: NASA TM 84010, October 1891.

ICCG, 1981: Interagency Coordination Committee for Geodynamics, Application of Space Technology to Operational Geodynamic and Geodetic Measurement Services: July 1981.

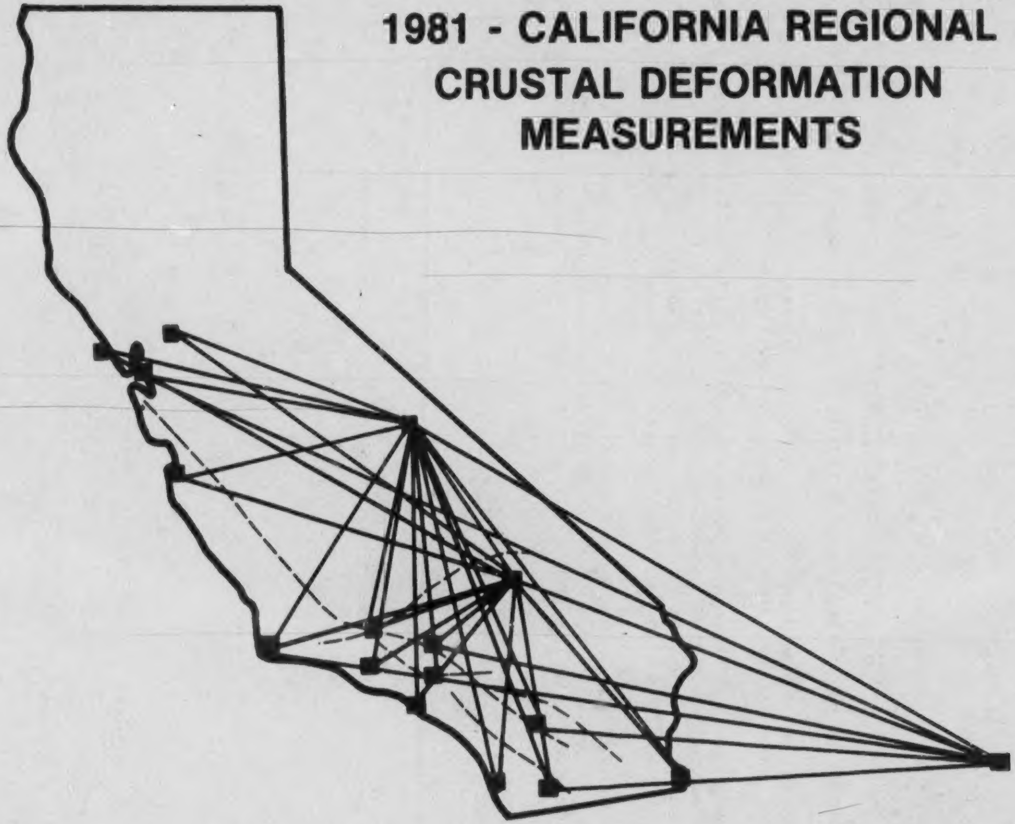
NASA, 1981b: National Aeronautics and Space Administration, Goddard Space Flight Center, Data Management Plan for Crustal Dynamics Project: H.G. Linder, GSFC X0931-81-18, July 1981.

NASA, 1982: National Aeronautics and Space Administration, Geodynamics Program Office, (Abstracts) Fourth Annual Conference on the NASA Geodynamics Program, January 26-19, 1982.

FIGURE CAPTIONS

1. 1981-California Regional Crustal Deformation Measurements
2. National Crustal Motion Network (NCMN)
3. 1981-Plate Motion and Plate Stability Measurements using VLBI
4. 1981-Plate Motion, Polar Motion, and Universal Time Measurements using Satellite Laser Ranging
5. NOAA Polaris Network
6. Lageos Polar Motion Measurements, May 1976-August 1981
7. Comparison of baselines determined by Lasers and VLBI
8. Magsat Anomaly Map; (a) Z-component (vertical); (b) X-Component (North); (c) Y-component (East)
9. Geopotential Research Mission concept. Satellite-to-satellite tracking antennas protrude above and below the spacecraft. Scalar and vector magnetometers, and star cameras are mounted on the rigid boom on the forward spacecraft.
10. Engineering model of a single axis cryogenic gravity gradiometer. Mounting provisions are included for two additional units which are under construction.

1981 - CALIFORNIA REGIONAL CRUSTAL DEFORMATION MEASUREMENTS



NASA HQ EL82-781 (1)
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FIGURE 1

National Crustal Motion Network (NCMN)

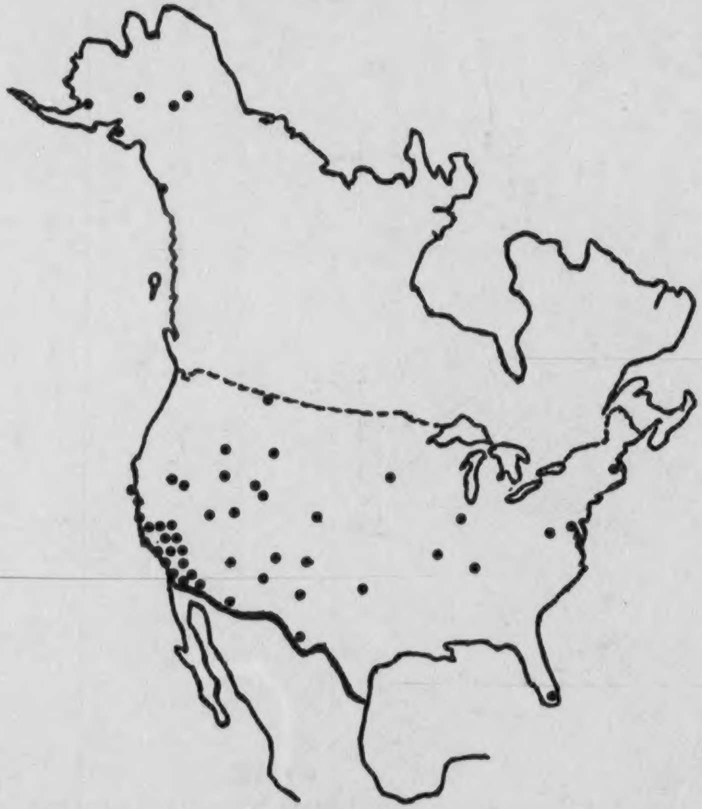

FIGURE 2

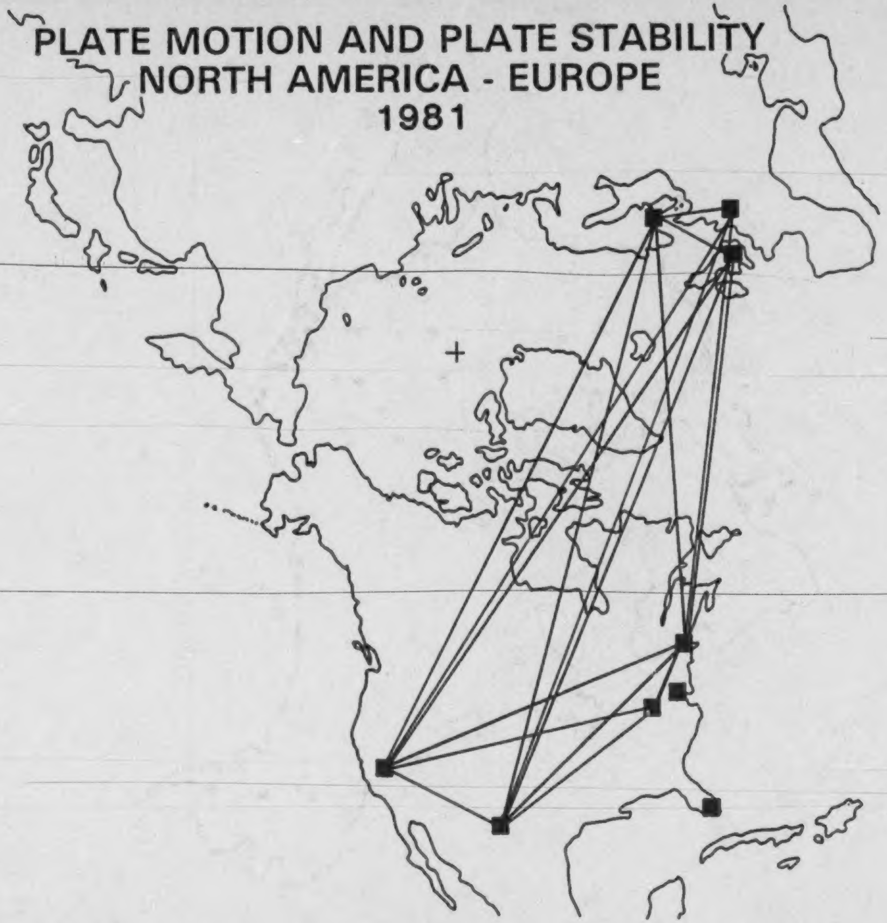

PLATE MOTION AND PLATE STABILITY
NORTH AMERICA - EUROPE
1981

FIGURE 3

PLATE MOTION AND PM/UT
1981

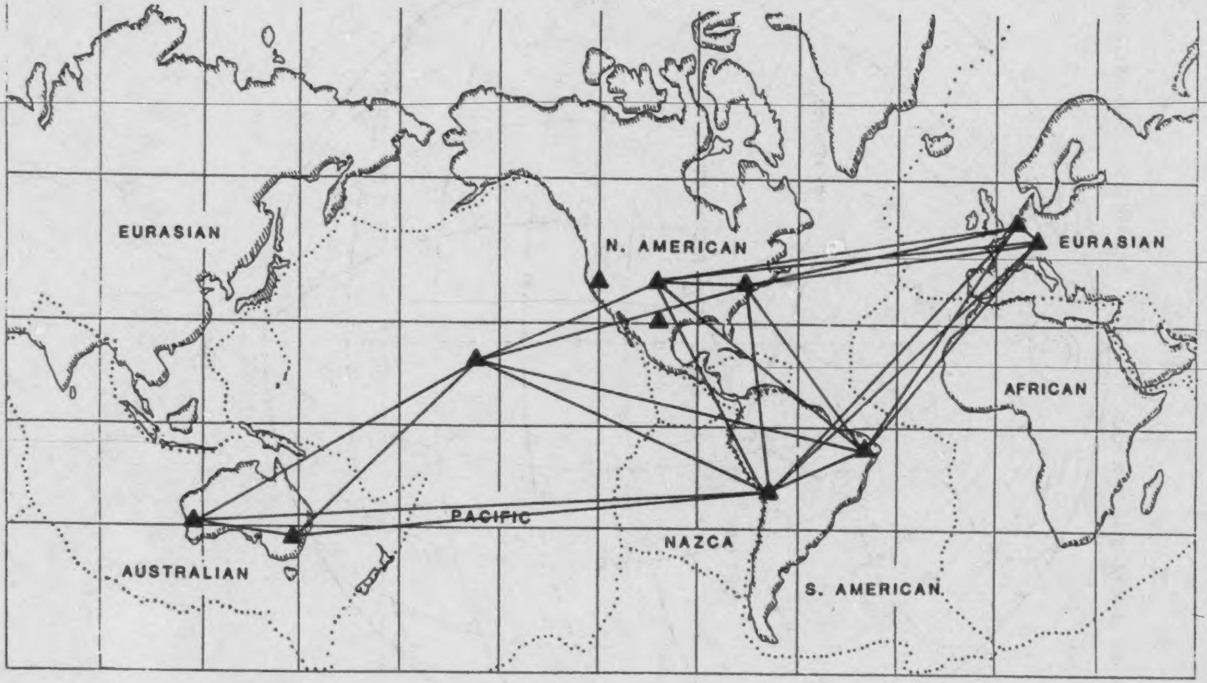
EURASIAN
N. AMERICAN
EURASIAN
AFRICAN
PACIFIC
NAZCA
AUSTRALIAN
S. AMERICAN

FIGURE 4

POLARIS

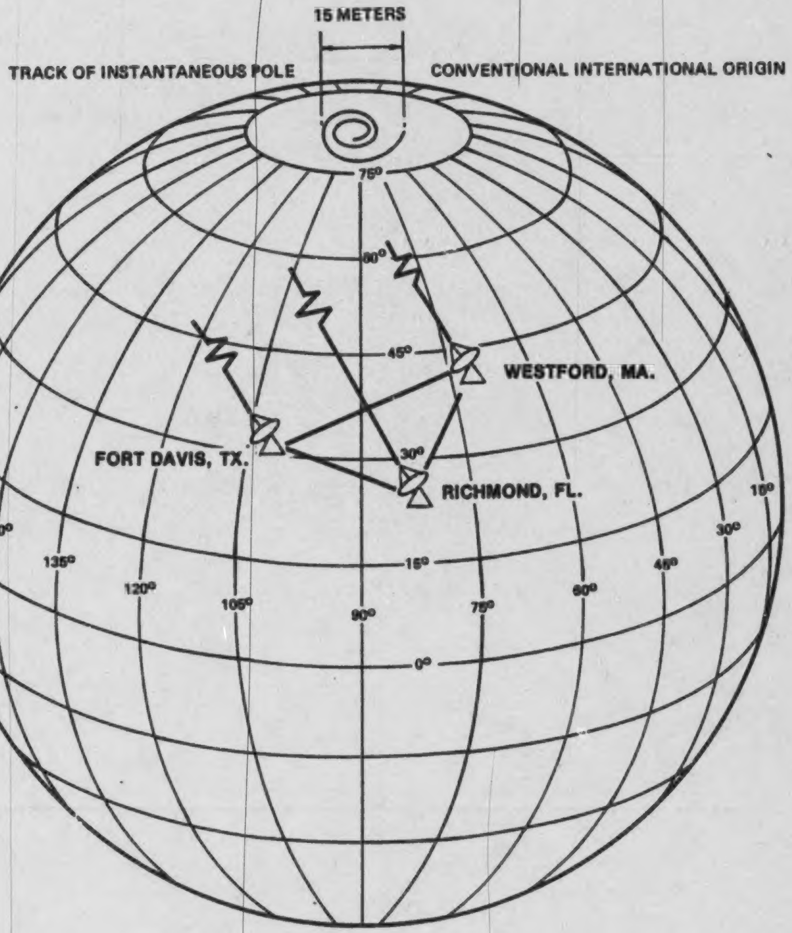
15 METERS
TRACK OF INSTANTANEOUS POLE
CONVENTIONAL INTERNATIONAL ORIGIN
75°
60°
45°
WESTFORD, MA.
FORT DAVIS, TX.
30°
RICHMOND, FL.
165°
150°
135°
120°
105°
90°
75°
60°
45°
30°
15°
15°
0°

FIGURE 5

LAGEOS POLAR MOTION MEASUREMENTS
MAY 1976 - AUGUST 1981

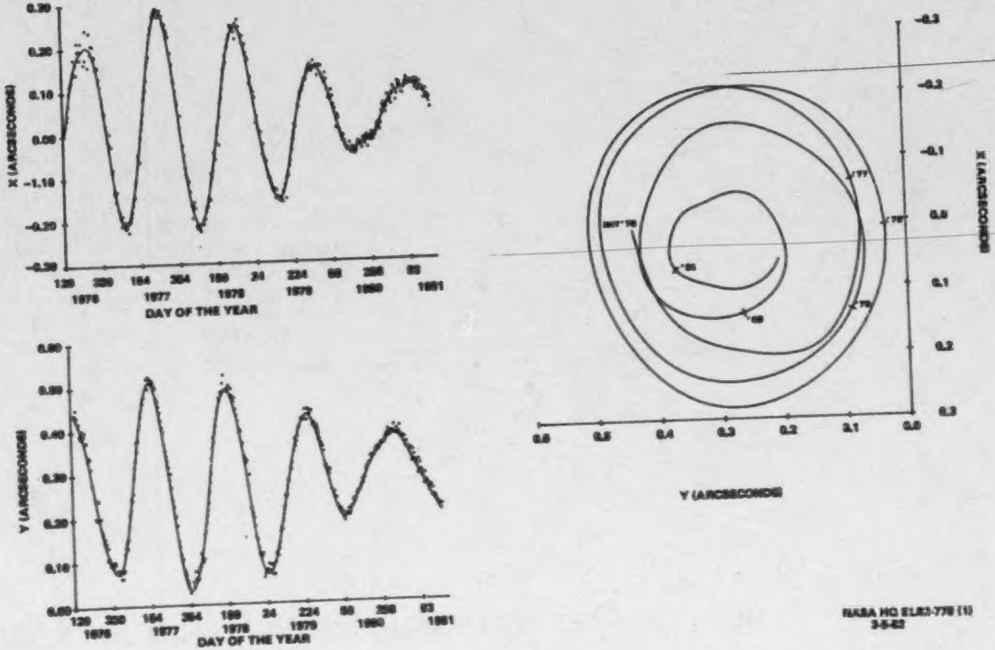

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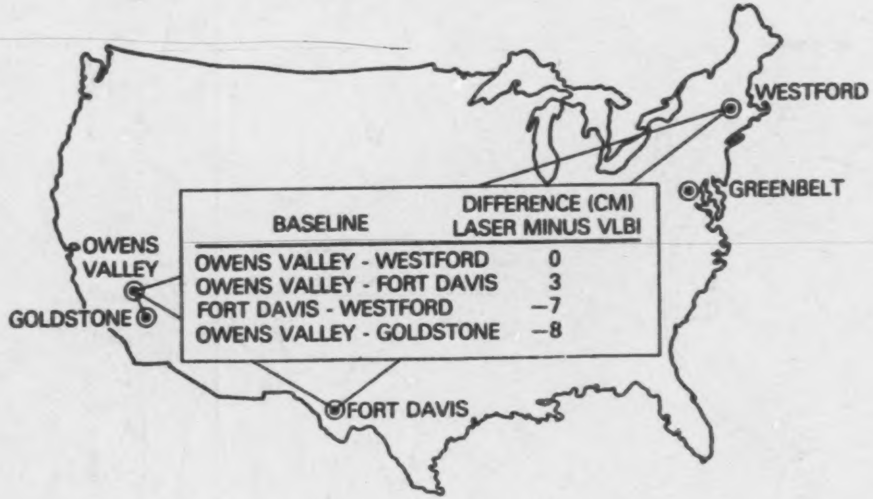
FIGURE 6

BASELINE DIFFERENCES BETWEEN LASERS AND VLBI


WESTFORD
GREENBELT
OWENS VALLEY
GOLDSTONE
FORT DAVIS

BASELINE	DIFFERENCE (CM) LASER MINUS VLBI
OWENS VALLEY - WESTFORD	0
OWENS VALLEY - FORT DAVIS	3
FORT DAVIS - WESTFORD	−7
OWENS VALLEY - GOLDSTONE	−8

FIGURE 7

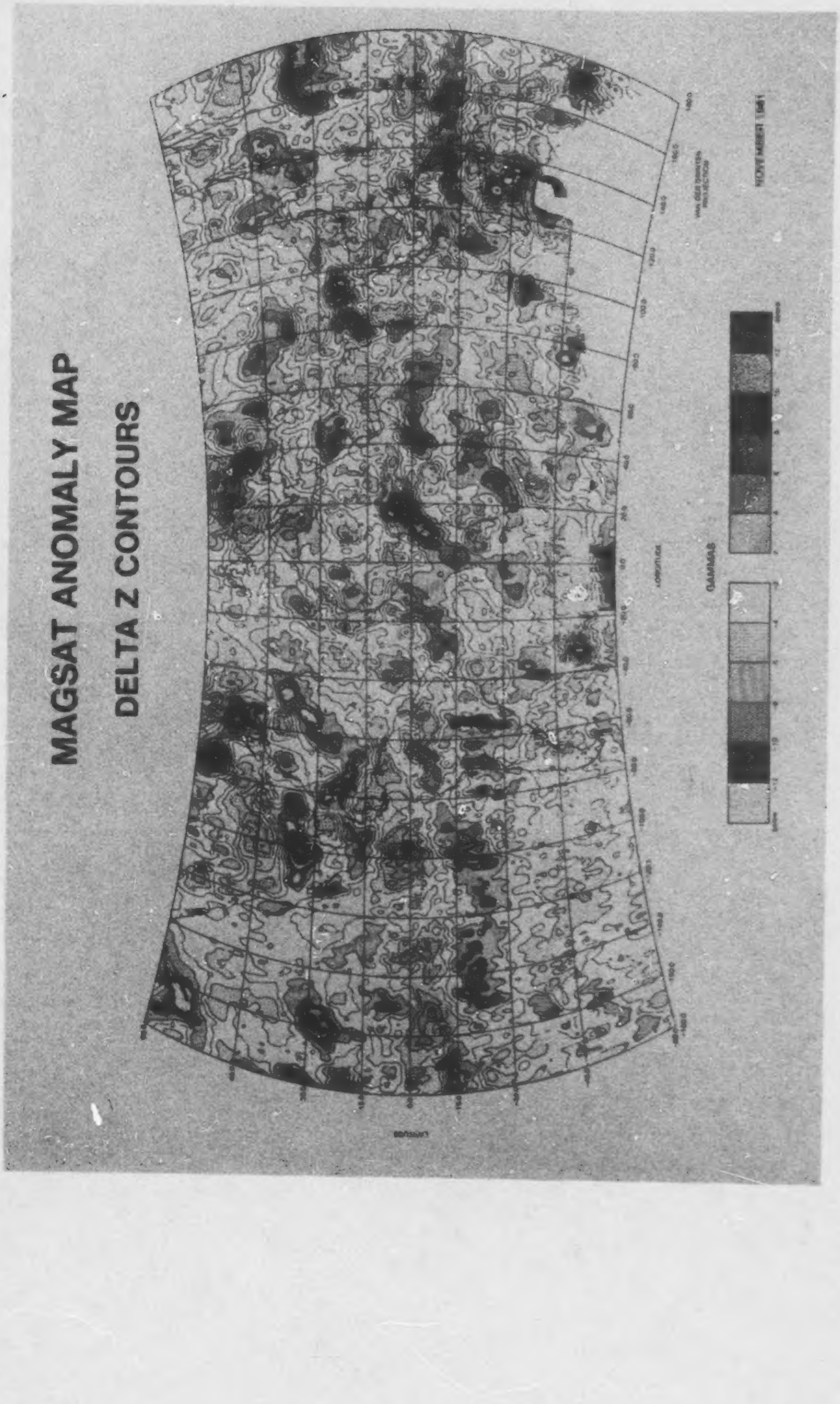

MAGSAT ANOMALY MAP
DELTA Z CONTOURS
LONGITUDE
LATITUDE
GAMMAS
VAN DER GRINTEN PROJECTION
NOVEMBER 1981

FIGURE 8A

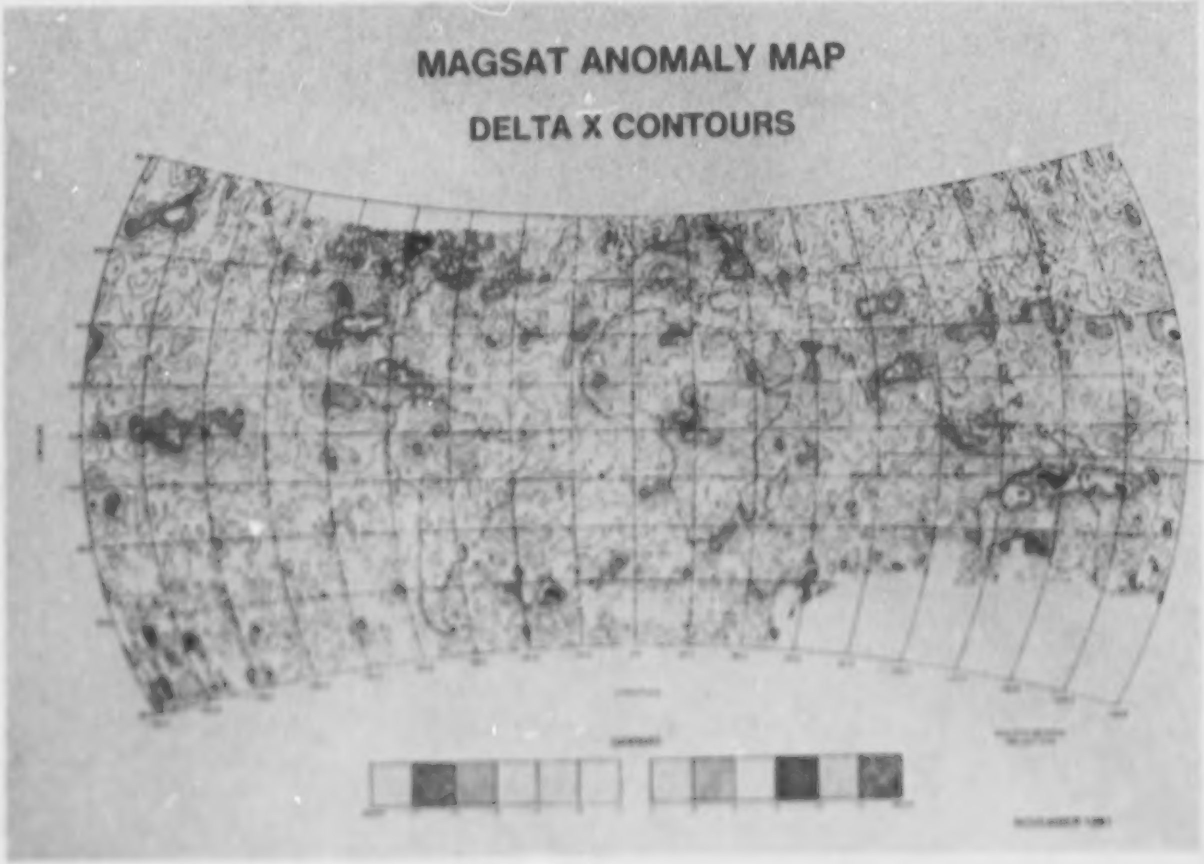

MAGSAT ANOMALY MAP
DELTA X CONTOURS

FIGURE 5b

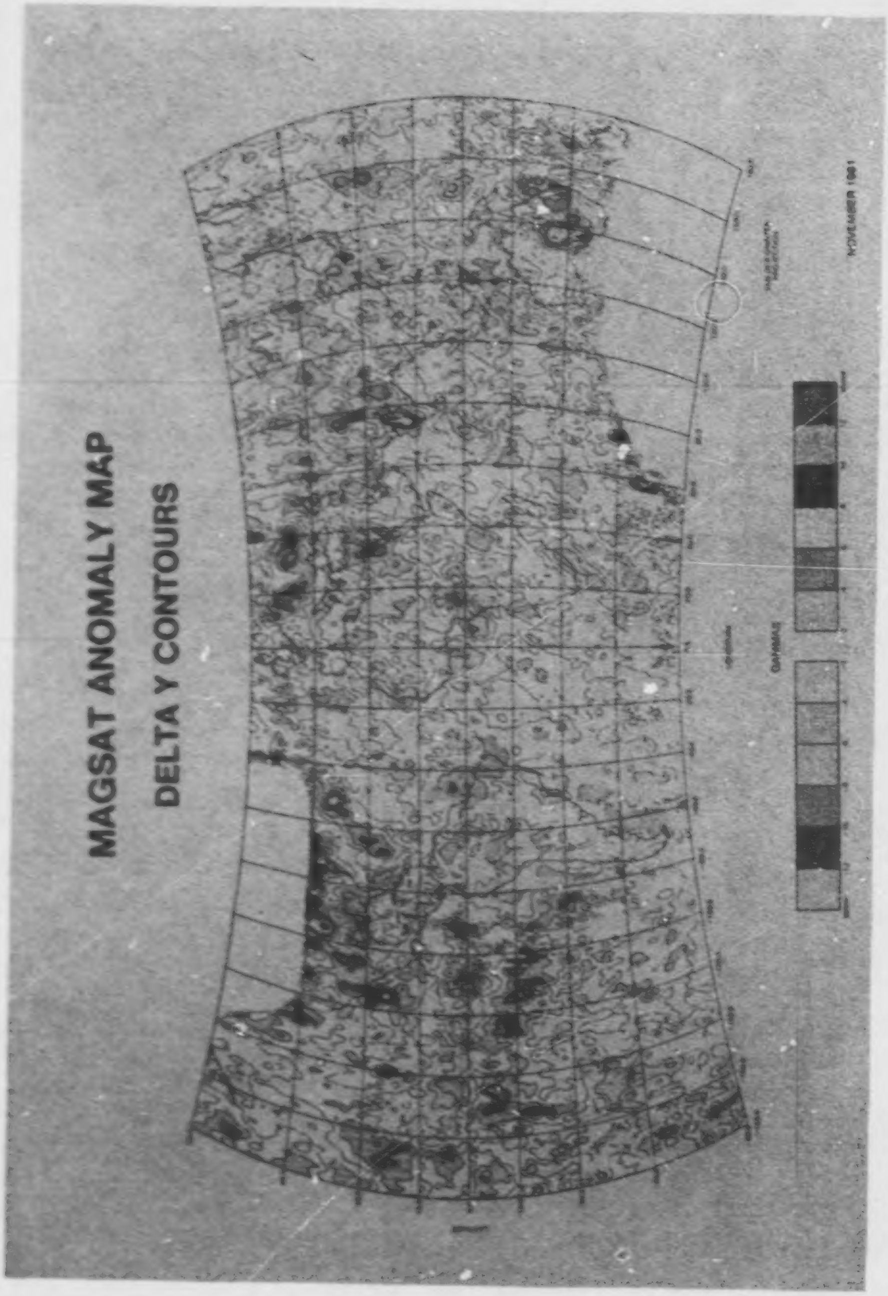
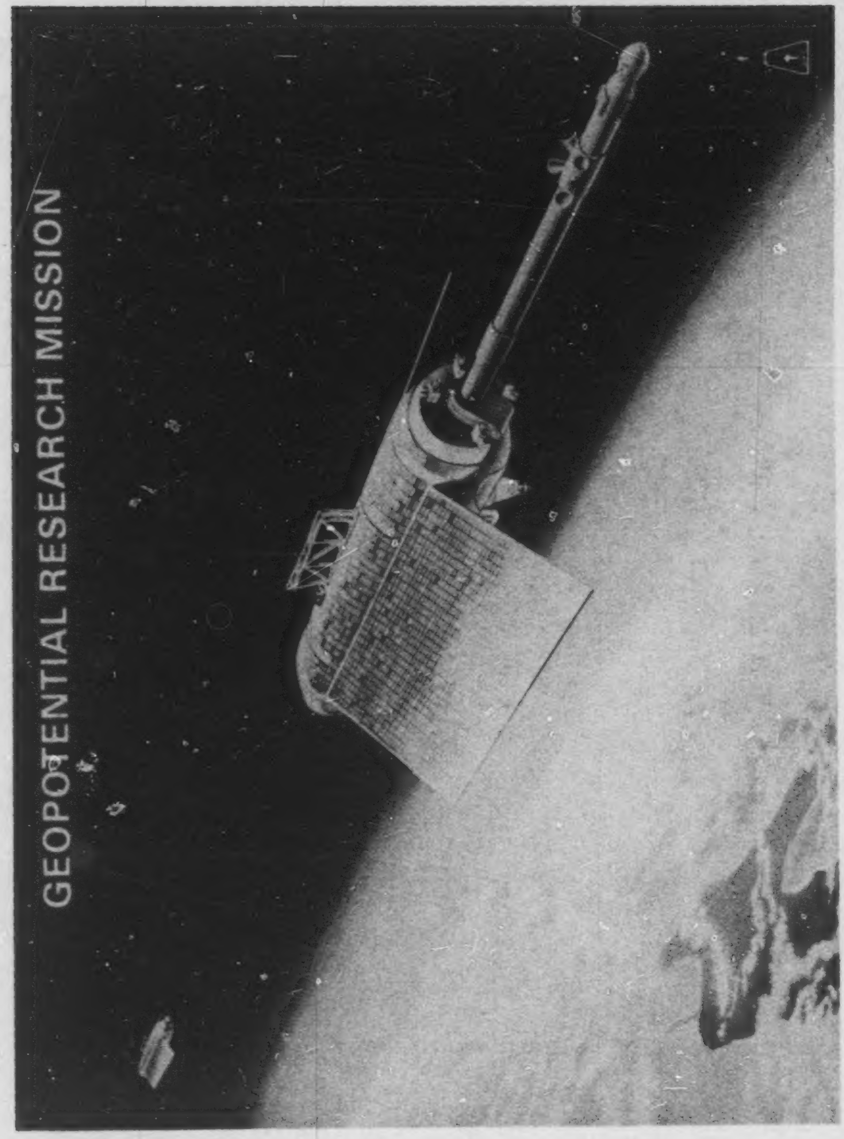

MAGSAT ANOMALY MAP
DELTA Y CONTOURS
GAMMAS
NOVEMBER 1981

FIGURE 8c



GEOPOTENTIAL RESEARCH MISSION

FIGURE 9

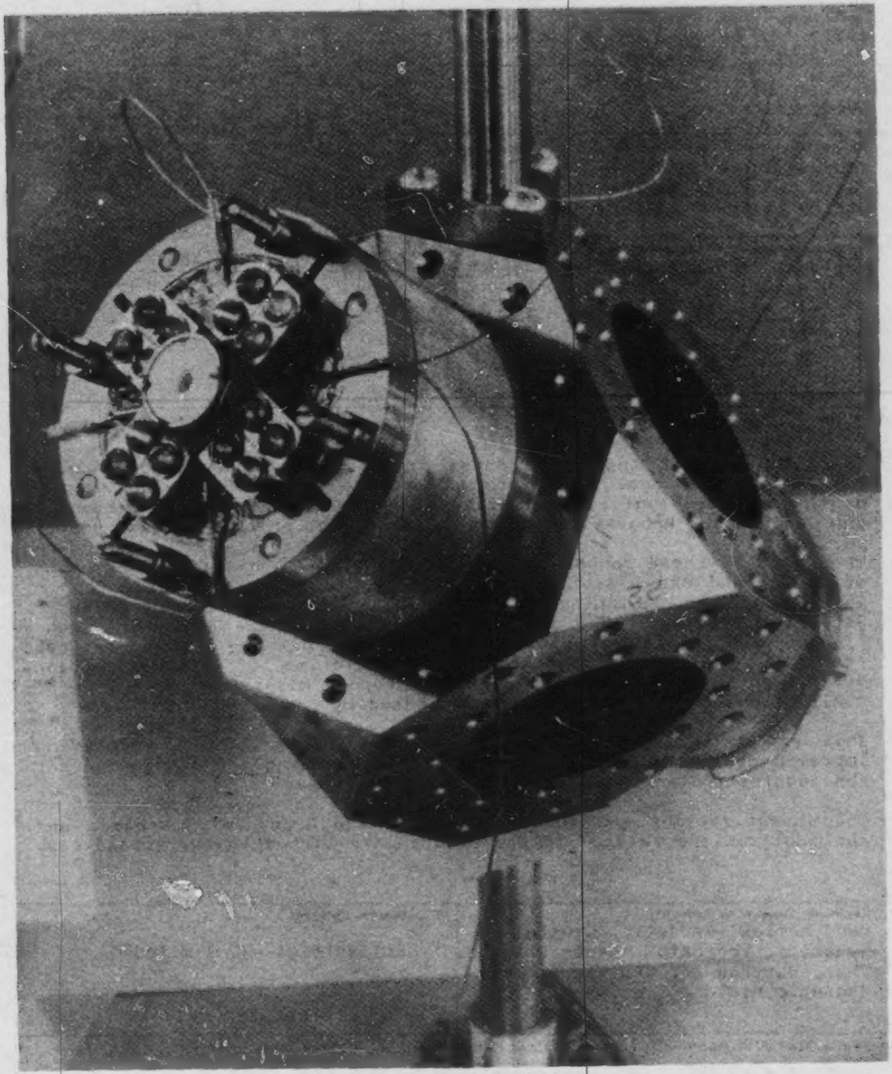


FIGURE 10

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15. Supplementary Notes

16. Abstract

This document is the third annual report of the NASA Geodynamics Program. Its purpose is to inform interested agencies and individuals of the status, progress, and plans of the program. The intention of the Geodynamics Program Office is to issue similar reports each year.

The first of these annual reports (NASA TM-81978) contained a section of background and historical information, to bring the reader up to 1979 since the beginning of the program as the National Geodetic Satellite Program. The second annual report (NASA TM-84010) highlighted the progress in instrumentation development and theoretical research, and the preparation for initiation of crustal motion measurements in the western U.S. This report also included a list of publications of research results supported by the Program.

This report reflects the progress made in 1981, both in achieving improved measurement precision and in establishing the foundation for the acquisition and analysis of scientific data.

The investigations and investigators in the Geodynamics Program and the publications related to the Program are listed in the appendices.

17. Key Words (Suggested by Author(s))
Geodynamics, Geodetic, Crustal Dynamics, Tectonics, Laser Ranging, VLBI, Earthquake, Gravity Field, Magnetic Field

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Enclosure 3

INTERAGENCY AGREEMENT
AMONG THE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

UNITED STATES GEOLOGICAL SURVEY

NATIONAL SCIENCE FOUNDATION

AND THE

DEFENSE MAPPING AGENCY

FOR A

JOINT PROGRAM FOR THE APPLICATION OF SPACE

TECHNOLOGY TO CRUSTAL DYNAMICS AND EARTHQUAKE RESEARCH

I. PURPOSE

The purpose of this agreement is to provide a framework for coordination within the Federal government of research and development in the application of space technology to studies of global crustal movement and deformation and related earthquake mechanisms.

The primary goals of the joint effort are to acquire new knowledge about the contemporary motion of the major tectonic plates; the forces that drive the plates; the existence of intraplate deformation; the accumulation and release of strain at plate boundaries; and the significance of variations in the earth's polar motion and rotation rate. This new knowledge is expected to lead to better understanding of dynamic processes in the solid earth, and of the causes and occurrence of earthquakes. This effort will also lead to cost-effective methods of establishing and maintaining the geodetic control networks of the United States.

Specifically, this agreement identifies the roles and responsibilities of the participating agencies; establishes a management structure to ensure maximum utility of related agency resources; provides for the transfer of appropriate technology to operational agencies; and provides for the preparation and approval of a detailed plan for the joint program.

II. IMPLEMENTATION RESPONSIBILITIES

The responsibilities for implementing this agreement shall reside in the following organization elements:

- Within the National Oceanic and Atmospheric Administration (NOAA)

  The National Geodetic Survey (NGS) of the National Ocean Survey (NOS)

- Within the National Aeronautics and Space Administration (NASA)

  The Resource Observation Division of the Office of Space and Terrestrial Applications (OSTA)

- Within the United States Geological Survey (USGS)

  The Geologic Division
  The National Mapping Division

- Within the National Science Foundation (NSF)

  The Division of Earth Sciences

  The Division of Astronomical Sciences

- Within the Defense Mapping Agency (DMA)

  The Advanced Technology Division within the Directorate of Systems and Techniques. DMA will coordinate the related activities of the U.S. Naval Observatory (USNO), the Air Force Geophysics Laboratory (AFGL), and other DOD organizations as appropriate.

III. BACKGROUND

During the past fifteen years, the development of the plate tectonics model for large-scale geological processes has revolutionized the study of the earth. The general geographical distribution of earthquakes can be explained by the plate tectonics concept, but the time, place, and magnitude of individual earthquakes is not explained. The forecasting of earthquakes, one of the major unsolved questions in geophysics today, is of considerable economic and social importance, and is addressed under a research program established by the Earthquake Hazard Reduction Act of 1977 and led by the United States Geological Survey (USGS).

For a comprehensive study of plate movement and deformation, five areas of concentration are required:

A. Observation of the relative motion of the major tectonic plates, and changes in the position and orientation of the plates.

B. Measurements of regional crustal deformation within about one thousand kilometers of active plate boundaries.

C. Measurement of crustal strain in the vicinity of fault systems.

D. Measurement of vertical and horizontal movements near the epicenters of major earthquakes or near places where major earthquakes are predicted.

E. Measurement of the earth's gravity field to detect gravity anomalies caused by variations in the distribution of mass within the earth. This information is important in studying the mechanical properties of the plates and to study mantle convection, an important candidate among possible driving mechanisms for the plates.

In the past ten years, space techniques for accurate position determination have been developed to complement and extend conventional geodetic surveying methods. One technique uses radio noise from distant radio sources (quasars) for very long baseline microwave interferometry (VLBI), a technique originated by radio astronomers and widely used by them; the other uses laser ranging to satellites in known orbits to determine positions of the lasers on the ground. Both VLBI and laser ranging appear capable of attaining a position accuracy of two to five centimeters over distances of a few hundred to thousands of kilometers. Both can be conducted from fixed observatories or from small mobile stations. NASA, with the assistance of the National G-odetic Survey, is presently conducting validation and intercomparison studies of both methods. Prototype fixed and mobile stations of each type are currently being used in NASA research projects.

Alternative methods, which are under study for the densification of geodetic networks, include the use of the Global Positioning System (GPS) satellites as radio sources for VLBI and high-accuracy geodetic position receivers, other radio techniques, a space-borne laser system ranging to passive retroreflectors on the ground, and improved conventional electromagnetic distance measuring instruments. Each of these methods appears capable of monitoring relative local movements over distances of twenty to one hundred kilometers, with two to three centimeters accuracy.

IV. AGENCY ROLES

The application of space technology to crustal dynamics and earthquake research by the Federal agencies in the time period 1980 to 1986 is projected to consist of three broad activities. These are:

A. Fixed observatory operations;

B. Mobile laser ranging, VLBI station operations, and high-precision GPS-based geodetic position surveys;

C. Study of improved local geodetic methods.

The fixed observatory operations will be used to obtain polar motion (PM) and earth rotation or universal time (UT) data and to monitor global plate motion. In addition, the fixed VLBI observatories will act as components of a network of VLBI stations for determining crustal movement, deformation, and strain. The lead agencies for the fixed VLBI observatory operations are NASA, NOAA and NSF. NASA will develop and validate the VLBI technology and transfer it to the National Geodetic Survey (NGS) of NOAA, which has the responsibility for monitoring polar motion on a regular basis. The United States Naval Observatory (USNO) operates a Connected Element Interferometer (CEI) for continuous PM and UT monitoring.

In the area of mobile laser and VLBI station operations, the lead agencies are NASA, NGS, and USGS. NASA has the primary responsibility for developing and validating the performance and use of these systems and for transfer of the new techniques to NGS and USGS. NGS will begin domestic operations with a NASA-developed mobile VLBI station in 1983, and will provide supporting gravity and geodetic surveys and data analysis. NGS operations will provide for monitoring North American plate stability.

NASA, NOAA, DMA, and USGS will coordinate the development of advanced techniques for improved geodetic measurments at the local scale.

The specific agency roles and responsibilities will be as follows:

A. NOAA

1. Provide an advanced VLBI polar motion monitoring system.

2. Provide local gravity and site survey measurements in support of mobile station operations in the United States and U.S. territories.

3. Provide monitoring, on an operational basis, of regional crustal deformation in the United States.

4. Support studies of the Global Positioning System for local measurements.

B. NASA

1. Develop, demonstrate, and transfer

space-derived technologies to other agencies.

2. Initiate regional measurements at North American sites, expanding to other parts of the world; establish and coordinate a global network for monitoring of plate motion.
3. Support investigator studies of tectonic processes, and of the earth as a planet.
4. Study the use of space systems for a global survey of the earth's gravity field.

C. USGS

1. Define requirements for crustal motion monitoring, and support geophysical research using data acquired by fixed and mobile systems.
2. Establish criteria for rapid deployment of mobile stations to study pre-seismic and post-seismic crustal movements.
3. Participate in the development of advanced measuring systems.

D. NSF

1. Make available radio antenna facilities at NSF sites, as appropriate, in support of fixed VLBI measurements.
2. Support geophysical research using data acquired by fixed and mobile systems.

E. DMA

1. Arrange for logistic support through USNO for NGS polar motion operations at Richmond, Florida.
2. Participate in the development of advanced measuring systems as they relate to geodesy and geodetic techniques.
3. Arrange for USNO to provide CEI results for comparison with VLBI observations.
4. Serve as the focal point for the development

of application of GPS to support geodesy both within and outside DOD.

V. MANAGEMENT

A. Program Review Board (PRB)

The activities under this agreement shall be under the overall policy guidance of the signatories as members of a Program Review Board. The PRB shall, at least annually:

1. Review the program to assess progress;
2. Assess the need for changes of emphasis or direction; and
3. Resolve issues brought forward by the Interagency Coordinating Committee (ICC).

B. Interagency Coordinating Committee (ICC)

The ICC will be composed of one representative from each of the implementing organizational elements defined in Section II. The committee, operating within the overall policy guidelines of the PRB, will meet at least quarterly to:

1. Review agency plans to assure that the various agencies' activities are properly coordinated;
2. Review appropriateness and adequacy of joint programs with other countries;
3. Assess progress and evaluate the readiness of the operational agencies to undertake routine observations with the new technology;
4. Recommends actions for implementation by the management of the various agencies.

VI. FEDERAL IMPLEMENTATION PROGRAM PLAN

The Federal Implementation Program Plan will be approved by the ICC as the controlling document for the program. This plan will detail the program objectives and the responsibilities of each agency to meet these objectives by program elements, expected accomplishments, schedules, and resources. This document will be controlled by the ICC and changes will be issued when approved.

VII. RESOURCES

Each agency is expected to provide and manage its resources necessary to meet agreed-upon commitments, subject to the availability of appropriations. Where appropriate, and upon prior agreement, funds may be transferred between the agencies for the accomplishment of responsibilities outlined in this Agreement.

VIII. PUBLIC AFFAIRS PRESS LIAISON

Public Affairs officers of the agencies involved in this Agreement will coordinate all agency press releases and other public affairs and press activities with their counterparts in the other agencies, except that each agency shall retain the authority to approve press releases initiated by investigators outside of the government which are funded by the agency. Press releases may be made simultaneously by all agencies or by a single agency with the concurrence of the other agencies.

IX. AMENDMENTS AND REVIEW

This Agreement may be amended at any time by mutual agreement of the signatories. This Agreement will be reviewed periodically, at least annually, by all participating agencies. Each agency agrees that the agency representative to the ICC will inform the other agencies of major changes in policy, budgets, or procedural practices in its agency which may affect its participation in this Agreement.

X. EFFECTIVE DATE, DURATION, AND TERMINATION

This Agreement will remain in effect from the date of the last signature until its termination on September 30, 1986. An agency may withdraw from this program upon 90 days written notice to the other agencies. This Agreement is subject to mutual termination at any time.

XI. OTHER PROVISIONS

This Agreement shall be modified, as necessary, to be consistent with changes in the law or Executive Orders.

James P. Walsh

James P. Walsh
Acting Administrator
National Oceanic and
Atmospheric Administration

Donald N. Langenberg

Dr. Donald Langenberg
Acting Director
National Science Foundation

Anthony J Calio 6/9/80

Anthony J. Calio
Associate Administrator for
Space and Terrestrial
Applications
National Aeronautics
and Space Administration

H William Menard

H. William Menard
Director
United States Geological Survey

9/[illegible]

Owen W. Williams
Deputy Director for Management
and Technology
Defense Mapping Agency

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310

4 MAR 1983

Honorable Doug Walgren
Chairman
Subcommittee on Science,
  Research and Technology
Committee on Science and
  Technology
House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

This is in reply to your letter to the Secretary of Defense, dated December 8, 1982, concerning the Department of Defense's (DOD) roles and responsibilities for implementing the National Earthquake Hazards Reduction Program.

Your letter requested a summary of the DOD's past and current research and service programs, budget history and future programs; also, an explanation of the agency's coordination of its activities with other Federal agencies, private industry and state and local governments.

The attached summary report contains the information requested. This information is oriented primarily to facilities and facilities support systems. The U.S. Army Corps of Engineers and the Naval Facilities Engineering Command are the two DOD construction agents. As these organizations also provide to the U.S. Air Force the majority of its construction support, they share the majority of the efforts identified in the report.

I hope the attached information is helpful to your review of this important national program.

Sincerely,

J R Sculley
J. R. Sculley
Assistant Secretary of the Army
(Research, Development and Acquisition)

Attachment

DEPARTMENT OF DEFENSE

SUMMARY REPORT OF ACTIVITIES

UNDER THE

NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

GENERAL.

The DoD is involved actively in the accomplishment of the stated objectives of the Earthquake Hazards Reduction Act of 1977 (P. L. 95-124). The concern and involvement with earthquake hazards has a long history. Local and state seismic design codes were applied in the design and construction of DoD facilties as soon as these were adopted in the 1930's. Since the occurrence of the Alaska earthquake of 1964, the DoD programs of research and criteria and standards development have increased. In 1966 the first edition of the Tri-Service (Army, Navy and Air Force) Seismic Design Manual was published. This manual provides the guidance for incorporation of earthquake-resistance in the design and construction of military facilities worldwide.

DoD activities associated with earthquake hazards mitigation include: research, investigations and studies, programs of education for designers and constructors, development of design criteria and standards, and development and increased use of computer-aided methods of aseismic structural design. Coordination activities have been established and maintained with other Federal agencies, national foundations, international programs and engineering societies.

Appended to this summary report is a budget summary for the DoD agencies activities under the National Earthquake Hazards Reduction Program; and descriptions of each agency's past, current and future activities under the program.

2. RESEARCH.

DoD agencies have been involved actively in research with the purpose of developing or improving methods and criteria and standards to improve the earthquake resistance of buildings and dams. This work is being accomplished primarily in service laboratories.

The U. S. Army utilizes two laboratories. They are the U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, Illinois, for the Military Construction Program and U. S. Army Waterways Experiment Station, (WES), Vicksburg, Mississippi, for the Civil Works Program.

The U. S. Navy utilizes the U. S. Naval Civil Engineering Laboratory (NCEL), Port Hueneme, California.

The U. S. Air Force research activities have been limited because of Army and Navy research results have been applied to the Air Force program as appropriate.

3. INVESTIGATIONS AND STUDIES.

Presently, during the design of new building facilities and the upgrading of existing facilities, the seismic hazards are considered and proper earthquake-resistance incorporated. However, each of the services has a large number of existing facility installations on which a majority of the facilities were designed and built before the earthquake hazard was well defined and understood. An important activity is to determine the extent of the seismic hazard for these older facilities; and to schedule seismic resistance upgrading for those deficient by present standards at the earliest opportunity.

In 1972 the Navy started a program to evaluate the seismic hazards of existing buildings on an installation basis. They have made extensive studies of their existing facilities and screened approximately 6,000 structures in seismic zones 3 and 4. Over 600 structures have been selected and individually structurally evaluated. The other screened-out structures did not require further structural analysis. Their work also included project-by-project type investigations and studies. The funds for FY 84 and 85 are $3,300,000 and $2,000,000, respectively.

The Army is completing a prototype research project for a hazard indexing and prioritizing system (HIPS) to be applied to seismically upgrade existing buildings on a base. Fort Ord in California was used as the test case. Nineteen buildings were screened to be structurally evaluated in detail and be considered for strengthening. Those considered essential to the mission of the base which are required to have post earthquake operations capability will be initiated first. The Navy's preliminary rapid seismic analysis procedure was used to evaluate the buildings and the results are to be compared with General Services Administration's (GSA) SAFEM software program. The funds required for FY 84 and 85 are estimated to be $1,000,000 each year. This funding is for the work on Army bases in seismic zones 3 and 4.

The Air Force similarly plans to investigate their bases by utilizing the Army's procedure and will also require about $1,000,000 in each of FY 84 and 85.

The cost of past seismic investigations and studies for individual projects for the Army and Air Force is not reflected in the DoD summary except for the Army's $330,000 listed in Pre-1978 activity.

New and existing hospitals in areas of high seismicity are considered to be vitally needed after a disastrous earthquake. Mission essential facilities are seismically investigated and designed for post-earthquake operational capability.

All seismic strengthening of existing hospitals thus far has been accomplished in conjunction with the upgrading of mechanical, electrical and safety systems to meet the accreditation standards of the Joint Commission on the Accreditation of Hospitals (JCAH). Also, existing barracks and bachelor officers' quarters are upgraded for seismic resistance in conjunction with renovation and/or modernization projects.

4. DESIGN CRITERIA AND GUIDLINES.

The Tri-Services first published a technical manual, Seismic Design for Buildings, in 1966 under the management of the Army Corps of Engineers. The Tri-Services Ad Hoc Committee reflected the trend toward increased design requirements, increased estimates of risk and concern for the adequacy of existing structures. The need for this manual was prompted from the damages suffered by facilities in the Alaska earthquake of 1964. The manual was based upon the Uniform Building Code and the committee added recommended details not available in other publications. In 1973, the second edition was published which reflected the lessons-learned from the 1971 San Fernando Earthquake and included the latest changes to the Structural Engineers Association of California's (SEAOC), Recommended Lateral Force Requirements. The design and details of tie-downs, braces, and anchorages for electrical, mechanical and other utility systems were incorporated. In 1982, the third edition was published to include the latest design concepts and 1980 SEAOC design recommendations. Also, there are two seismic design guidelines currently being developed - one for new essential facilities and the other for existing essential facilities. These guidelines will require the analysis of these buildings utilizing the latest dynamic methods to incorporate the most cost-effective earthquake-resistance.

5. SEISMIC INSTRUMENTATION PROGRAM

DoD is involved in the Strong-Motion Instrumentation Program (SMIP). The Corps of Engineers is active in this program. The objective of the SMIP program is to provide insight into the safety of existing and new Corps structures. Additionally, it provides a measure of project performance and acts as a data base for earthquake research.

The SMIP had its inception during FY 70. Arrangements were made with the Seismic Engineering Branch, U.S. Geological Survey (USGS), to install and maintain Corps of Engineers (CE) instruments. During FY 78, WES assumed responsibility for the installation and maintenance of CE instruments primarily located in the eastern US. The USGS continues to maintain those instruments on the west coast.

The total number of projects, located in 34 states and one territory, instrumented as of 1 May 1982 was 104. Instruments in operation as of that date were 360 accelerographs, 59 seismoscopes, and 27 peak recording accelerographs (PRA's). Fifty-five accelerographs and 22 PRA's are planned for installation in future years.

Significant records were obtained at Coyote Dam, CA. and the first earthquake records representative of seismic activity in the New England area were obtained as a result of the 18 January 1982 Franklin Falls, NH, 4.8 magnitude event. Thirteen high-quality records (39 components) were recovered.

Future goals are to revise and update analytical procedures used for assessing the seismic stability of structures and to install devices on Corps structures to minimize on-site inspections after earthquakes.

Recently, strong-motion instrumentation systems were installed in two existing Army hospitals, Letterman Army Medical Center, Presido of San Francisco, CA, and Silas B. Hays Army Hospital, Fort Ord, CA.

The Navy has installed seismic strong-motion instrumentation for their dry dock certification program and in a few of the structures at selected locations.

6. EDUCATION PROGRAM.

The Army Corps of Engineers and the Naval Facilities Engineering Command sponsored two seismic design workshops for their field personnel in 1981. These workshops were provided because there was a urgent need and requirement to train and educate field personnel in seismic design. The Army has scheduled seismic design workshops in their 1984 and 85 training schedule. Several other earthquake analysis courses have been taught by the Corps, such as basic and advanced earthquake analysis courses related to dam design. The Air Force includes seismic design in their course at the Civil Engineering School, Wright-Patterson AFB, Ohio.

7. COORDINATION ACTIVITIES.

The DoD has been active in the National Hazards Reduction Program's, Interagency Committee on Seismic Safety in Construction (ICCSC). Representatives from the DoD, Army, Navy, and Air Force participate in various subcommittee work. Also, DoD components are represented in the National Institute of Building Science's (NIBS), Building Seismic Safety Council (BSSC), committee on trial designs of the National Science Foundation/National Bureau of Standards, "Tentative Provisions for the Development of Seismic Regulations for Buildings."

Earthquake Engineering is one of the topic areas in bi-annual conferences which are conducted jointly by the Corps, the Bureau of Reclamation, the Tennessee Valley Authority, and the Bonneville Power Administration. Other participants have included the Federal Emergency Management Administration, the Bureau of Mines, the Nuclear Regulatory Commission, and the Soil Conservation Service. The most recent in this conference series, the twelfth, was held at the U. S. Army Engineer Waterways Experiment Station in November 1981. These conferences are for the purposes of exchanging information about research to prevent duplication of effort.

The Ad Hoc Interagency Committee on Dam Safety was established by the Federal Coordinating Council for Science, Engineering, and Technology to prepare Federal guidelines for dam safety. The Department of the Army was represented on the committee, and the Corps had members on several of the task groups, including those on seismology and on seismic design.

The Corps is a member of the interagency Working Group for Coordination for Cooperative Earthquake Research with the People's Republic of China.

The Joint US-Japan Panel on Wind and Seismic Effects holds annual meetings for the purpose of exchange of information and data, including methods of analysis and design and data on earthquakes ground motions and their effects. The US participants are the Corps, Naval Facilities Engineering Command, National Bureau of Standards, the U. S. Geological Survey, the National Oceanic and Atmospheric Administration, the Nuclear Regulatory Commission, and the Bureau of Reclamation.

A national strong-motion instrumentation program is maintained by cooperative efforts of the Corps, the U. S. Geological Survey, the Veterans Administration, the National Science Foundation, and the State of California. Annual meetings are held to exchange information and coordinate instrumentation activities.

A few specific examples of cooperative activities by DoD personnel are: provide consultant services on earthquake engineering problems to the Nuclear Regulatory Commission(NRC), the Bureau of Reclamation, and the Soil Conservation Service; conduct earthquake related research under sponsorship of the NRC; serve as technical reviewers of research proposals submitted to the National Science Foundation; active members in the Earthquake Engineering Research Institute which is an organization of scientists and engineers, in Government, academia, and private industry, who are active in earthquake-related research and serves as a clearing house for information on research activities for the earthquake data; and also active on the Technical Committees of the American Society of Civil Engineers. The DoD has sponsored, under its R&D Programs, earthquake-related research at many univerisities, including the University of California at Berkeley, Massachuetts Institute of Technology, Harvard University, Cambridge University (England), and others.

APPENDIX TO
DEPARTMENT OF DEFENSE
SUMMARY REPORT OF ACTIVITIES
UNDER THE
NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM
BUDGET DATA AND RESEARCH

DEPARTMENT OF DEFENSE
SUMMARY OF
THE NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

Earthquake Hazard Reduction Act of 1977, P. L. 95-124

(Funding Levels, $ 000's)

WORK	PAST ACTIVITIES		CURRENT	FUTURE	
	PRE-1978	1978-1982	1983	1984	1985
1. RESEARCH					
Army:					
Mil Con	525	928	30	-	-
*Civ Wk	1,981	3,204	445	260	250
*Navy	200	420	160	100	100
Air Force	-	-	-	-	-
2. INVESTIGATION & STUDIES (Tech Reports)					
Army:					
*Mil Con	330			1,000	1,000
Civ Wk	-	-	-	-	-
*Navy	50	2,841	2,138	3,300	2,000
*Air Force	-	-	-	1,000	1,000
3. SEISMIC DESIGN CRITERIA & GUIDELINES (Tech Manuals)					
Army	150	150	211	-	-
Navy	-	200	-	-	-
Air Force	-	-	-	-	-
4. SEISMIC INSTRUMENTATION & SERVICE PROGRAMS					
Army					
*Mil Con		170	-	50	65
*Civ Wk	500	500	260	250	-
*Navy	-	188	16	12	12
Air Force	-	-	-	-	-
5. EDUCATION PROGRAM					
Army	90	135	-	35	35
Navy	15	20	5	-	-
Air Force	-	-	-	15	15
6. COMPUTER-AIDED DESIGN-SEISMIC					
*Army		10	10	15	15
Navy	-	-	-	-	-
Air Force	-	-	-	-	-
*7. SUPPORT FOR COORDINATION ACTIVITIES DOD (Army, Navy, Air Force)	20	20	10	20	20
TOTALS	3,861	8,786	3,285	6,057	4,512

*On-going work

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM
FUNDING LEVELS ($ 000's)
(U. S. Army Construction Engineering Research Laboratory)

MILITARY CONSTRUCTION PROGRAM

PROJECT/WORK UNIT	PRE-1978	1978-1982	1983	1984	1985	CATEGORY
1. Mission Affordable Seismic Strengthening	0	350	30	0	0	Research
2. Affordable Seismic Technology for Army Requirements	0	158	0	0	0	Research
3. Seismic Evaluation Plan for Installations in Zones 3 & 4	0	130	0	0	0	Research
4. Seismic Instrumentation Guidelines	0	50	0	0	0	Research
5. Earthquake Design Criteria for Interior Utility and Lifeline Systems	45	55	0	0	0	Research
6. Design Guide for Seismic Strengthening of Existing Buildings	75	35	0	0	0	Research
7. Earthquake Resistant Engineering and Design Criteria	365	0	0	0	0	Research
8. Aseismic Design Requirements for Medical Facilities	40	0	0	0	0	Research
9. Aseismic Design Criteria - Rehabilition of Existing Hospital Facilities	330	0	0	0	0	Investigation
10. Seismic Instrumentation System	0	170	0	50	65	Seismic Instrumentation

TOTAL FUNDING LEVELS

RESEARCH	525	928	30	-	-
INVESTIGATION	330	-	-	-	-
SEISMIC INSTRUMENTATION	-	170	-	50	65

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
RESEARCH FOR EARTHQUAKE HAZARDS REDUCTION
(U.S. Army Construction Engineering Research Laboratory)

WORK UNIT TITLE	PRODUCTS
1. Mission Affordable Seismic Strengthening: Develop a Hazard Indexing/Prioritizing System (HIPS) for OCE and base commanders to identify potentially seismically hazardous facilities and to prioritize the associated seismic strengthening at Army installations on the basis of seismic exposure, occupancy, acquisition cost, age and seismic safety investigations.	Seismic Indexing System for Army Installations 1. Volume IV Technical Assessment of Current Seismic Hazard Indexing and Damage Estimation Procedures, Technical Report (In Preparation). 2. Volume III Preliminary Analysis of the Seismic Vulnerability of Selected Buildings at Fort Ord, California, Using the Rapid Seismic Analysis Procedures, Technical Report (In Preparation). 3. Volume II Seismic Hazard Priority-Ranking Procedure for Army Buildings: Basic Concept, Technical Report M-290, May 1981. 4. Volume I Real Property Inventory Screening Procedure, Technical Report M-290, May 1981.
2. Affordable Seismic Tehcnology for Army Requirements: To verify the structural integrity of a critical seismic design detail used in the precast concrete barracks construction at Fort Ord, CA.	Lap Splice Test Results for Fort Ord Barracks, Letter Report, February 1982.
3. Seismic Evaluation Plans for Installations in Zones 3 and 4: To provide general guidance for (1) survey and evaluation of potential seismic hazards in existing essential buildings such as hospitals, fire stations, emergency operation centers and other mission-related buildings that must remain operational following a destructive earthquake; and (2) development of potential strengthening measures that can be used to mitigate earthquake hazards.	1. Seismic Evaluation and Upgrade Guidelines for Essential Facilities, Draft Engineer Technical Letter, Technical Report and Design Example, September 1979. 2. Current and Tentative Seismic Design Provisions for Buildings: Preliminary Comparison, Technical Report M-280, August 1979.
4. Seismic Instrumentation Guidelines for Army Installations: To establish a proposed strong-instrumentation program for building located on Army installations and thus provide a means for the verification and improvement of seismic design criteria for Army military construction.	Seismic Instrumentation Guidelines for Army Installation, Technical Report motion (In-Preparation).
5. Earthquake Design Criteria for Interior Utility and Lifeline Systems: To formulate procedures for establishing test criteria for seismic qualification of essential equipment in critical facilities by proof testing and fragility testing and to provide guidance for interpretation of test results.	1. Development and Use of Seismic Shock Test Criteria for Essential Equipment in Critical Facilities, Technical Report M-236, April 1979. 2. Fragility Data Analysis and Testing Guidelines for Essential Equipment Used in Critical Facilities, Special Report M-209, March 1977.
6. Design Guide for Seismic Strengthening of Existing Buildings: To develop guidance for engineers to use in strengthening buildings found to be deficient in seismic resistance, in particular, criteria for determining the suitability of specific strengthening schemes for a building and for the application of specific strengthening methods.	1. Methods for Seismic Strengthening of Buildings, Interim Report M-249, July 1978. 2. Guidelines for Evaluating the Seismic Resistance of Existing Buildings, Technical Report M-213, July 1977.

WORK UNIT TITLE	PRODUCTS
7. Earthquake Resistant Engineering and Design Criteria: To develop an appendix to TM 5-809-10, Seismic Design for Buildings, to provide guidance for the seismic design of critical military buildings to assure that essential services can be performed immediately following the occurrence of strong motion earthquakes.	1. Seismic Design Guidelines for Critical Buildings, (Appendix for Seismic Design for Buildings TM 5-809-10) March 1977. 2. Seismic Structural Design/Analysis Guidelines for Buildings, Special Report M-206, February 1977. 3. Seismic Design Methods for Military Facilities - Preliminary Recommendations, Interim Report M-184, June 1976. 4. Guidelines for Assessment of Site Dependent Seismic Ground Acceleration, Letter Report, May 1976. 5. Seismic Design Practices for Buildings, Special Report, February 1976. 6. Three-Dimensional Seismic Structural Analysis of Letterman Hospital, Technical Report M-176, January 1976. 7. Modal Analysis Methods in Seismic Design for Buildings, Technical Report M-132, June 1975. 8. Guidelines for Developing Design Earthquake Response Spectra, Technical Report M-114, June 1975. 9. Evaluation and Illustration of Waveform Synthesis Techniques for Earthquake Design and Analysis Application, Special Report, January 1974. 10. Seismic Design of Building Structures, Technical Report S-10, July 1972.
8. Aseismic Design Manual for Medical Facilities: To develop the seismic design chapter in TM 5-838-2, Army Health Facility Design, to provide guidance for the conceptual planning of new medical facilities to enable them to withstand a major earthquake and to remain functionally operational without disruption of necessary services or a serious threat to life safety.	Seismic Design Chapter for TM 5-838-2, Medical Facilities Design - Army, November 1976.
9. Aseismic Design Criteria - Rehabilitation of Existing Hospital Facilities: To survey and analyze Letterman Army Medical Center, Presidio of San Francisco, CA, and Hays Hospital, Fort Ord, CA, to develop design guidance, criteria and cost estimates for modifications required to strengthen susceptible systems to assure their past earthquake functionality.	1. Site-Dependent Maximum Probable Earthquake Criteria, Task Report, October 1973. 2. Dynamic Seismic Analysis of Primary Structural Systems for Letterman and Hays General Hospital, Volume I and II, Task Report, March 1974. 3. Damage Patterns for Primary Structural Systems, Task Report, April 1974. 4. Concepts for Strengthening Letterman and Hays Army Hospitals, Task Memorandum, January 1974. 5. Recommendations for Nonstructural Facility Systems Summary and Budget Cost estimate, Task Memorandum, June 1974. 6. Nonstructural Facility Systems, Volume I and II, Task Report, April 1974. 7. Exterior Utility Systems, Task Report, October 1974. 8. Existing Capacity & Strengthening Concepts for Letterman and Hays Hospitals, Task Memorandum, April 1974.

WORK UNIT TITLE	PRODUCTS
	9. Summary Report on Assessment of Liquefaction Potential at Letterman Hospital, Task Report, October 1974. 10. Alternate Strengthening Concepts Letterman and Hays Hosptials, Volume I and II, Task Memorandum, November 1974. 11. Requirements for Compliance with California Hospital Regulations, Task Report, December 1974.
10. Seismic Instrumentation System: To purchase 54 channels of seismic monitoring instrumentation for installation in Letterman Army Medical Center, Presidio of San Francisco, CA; Hay Hospital, Fort Ord, CA; and the hospital at Fort Campbell, KY.	Seismic Monitoring Systems Procured and Installed in Letterman Army Medical Center and Hays Hospital, September 1982.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM
FUNDING LEVELS ($ 000's)
(U. S. Army Waterways Experiment Station)

CIVIL WORKS

PROJECT/WORK UNIT	PRE-1978	1978-1982	1983	1984	1985	CATEGORY
1. Earthquake Resistance of Earth and Rock-Fill Dams	885	0	0	0	0	Research
2. Liquefaction	635	592	0	50	0	Research
3. Dynamic Stresses and Deformations	0	165	0	0	0	Research
4. Seismology	254	270	60	50	50*	Research
5. Induced Seismicity	87	354	75	0	0	Research
6. In Situ Testing	0	405	50	0	0	Research
7. Liquefaction of Gravelly Soils	0	120	60	10	0	Research
8. Remedial Actions	0	0	70	0	0	Research
9. Seismic Stability of Embankment Dams	0	0	0	100 (Total Anticipated through 1987-400)	100	Research
10. Seismic Design of Concrete Dams	20	124	0	0	0	Research
11. Dynamic Response of Concrete Dams	50	388	0	0	0	Research
12. Seismic Response of Concrete Dams and Appurtement Structures	0	561	100	50	100	Research
13. Interaction of Concrete Dams with Foundations	0	30	0	0	0	Research
14. Military RDT&E Program (AT 22): Earthquake Ground Motions	50	40	0	0	0	Research
15. Funded by Field-Operating Agencies: Strong-Motion Instrumentation Program	500	500	260	250	--	Seismic Instrumentation Servicing Program
16. Funded by Nuclear Regulatory Commission: Earthquake-Induced Settlement	0	155	30	0	0	Research

TOTAL FUNDING LEVELS $000's

RESEARCH	1,981	3,204	445	260	250
SEISMIC INSTRUMENTATION	500	500	260	250	0

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS

RESEARCH FOR EARTHQUAKE HAZARDS REDUCTION
(U. S. Army Waterways Experiment Station)

PROJECT/WORK UNIT TITLE	MAJOR PRODUCTS
1. EARTHQUAKE RESISTANCE OF EARTH AND ROCK-FILL DAMS. Development of methodology for analysis of earthquake-resistant design.	Technical report (GL-79-13), "Response and Stability of Earth Dams During Earthquakes," and other technical reports. Input to Earthquake Soils Response training course. Input to ER 1110-2-1806. Input to proposed preliminary Seismic Design Manual EM 1110-2-1814.
2. LIQUEFACTION. Mechanisms of liquefaction of soils in earth dams and foundations, and development of methods of testing and analysis to evaluate susceptibility of soils to earthquake-induced liquefaction.	Series of four technical reports (S-78-2), "Liquefaction Potential of Dams and Foundations;" technical report, "Investigation of Density Variations in Triaxial Test Specimens of Cohesionless Soil Subjected to Cyclic and Monotonic Loading;" and other technical reports. Input to ER 1110-2-1806. Input to Earthquake Soils Response Course.
3. DYNAMIC STRESSES AND DEFORMATIONS. Development of methods of analysis and prediction of earthquake-induced stresses and permanent deformations in earth and rock-fill dams	Methodology for dynamic analysis of earth dams applied to analysis of Richard B. Russell Dam, Georgia-South Carolina. Input to Earthquake Soils Response Course. Input to proposed preliminary Seismic Design Manual EM 1110-2-1814.
4. SEISMOLOGY. Methodology for geological and seismological assessment of earthquake hazards and specification of earthquake ground motions for engineering design.	Series of 12 technical reports (S-73-1) relating an established methodology for selection of design earthquakes. Input to ER 1110-2-1806. Input to Engineering Seismology training course.
5. INDUCED SEISMICITY. Evaluation of seismic hazards that may result from loading by reservoirs.	Series of 7 technical reports (S-73-1) including "The Evidence for Reservoir-Induced Macroearthquakes." Input to Engineering Seismology training course.
6. IN SITU TESTING. Methods of testing soils in situ to assess their susceptibility to earthquake-induced liquefaction.	Technical report (GL-82-6), "The FSD Probe: Simultaneous Measurement of Penetration Resistance and Pore Pressure." Prototype devices for in situ measurement of dynamic pore pressure and for in situ measurement of electrical resistivity. Input to Earthquake Soils Response Course. Input to proposed preliminary Seismic Design Manual EM 1110-2-1814. Input to ER 1110-2-1806.
7. LIQUEFACTION OF GRAVELLY SOILS. Methods of assessing susceptibility to earthquake-induced liquefaction in soils not amenable to present test methods.	Summary technical report. Input to Earthquake Soils Response Course. Input to Laboratory Testing Manual, EM 1110-2-1906. Input to proposed preliminary Seismic Design Manual EM 1110-2-1814.

PROJECT/WORK UNIT TITLE	MAJOR PRODUCTS
8. REMEDIAL ACTIONS. Evaluate the feasibility and probable effectiveness of various methods of treatment for dams or foundations found to be potentially unstable under seismic loading.	Feasibility technical report including interim guidelines for experiments and demonstrations. Input to Earthquake Soils Response Course.
9. SEISMIC STABILITY OF EMBANKMENT DAMS. Develop methods of analysis to compute seismically induced deformations of earth and rock-fill dams directly, and validate methods by field observations.	Technical reports describing methodology. Input to ER 1110-2-1806. Input to Earthquake Soils Response Course. Input to proposed preliminary Seismic Design Manual EM 1110-2-1914.
10. SEISMIC DESIGN OF CONCRETE DAMS. Development of interim methods of seismic design of, and analysis of seismic effects on, concrete dams. Combined with work unit under No. 12.	Draft technical report. Input to Earthquake Analysis training course. Input to ER 1110-2-1806.
11. DYNAMIC RESPONSE OF CONCRETE DAMS. Testing and analytical methods to determine the characteristics of the response of concrete dams subjected to earthquakes. Combined with work unit under No. 12.	Technical report (SL-81-7), "Comparison of Vibration Test Results for a Model and Prototype Gravity Dam."
12. SEISMIC RESPONSE OF CONCRETE DAMS AND APPURTENANT STRUCTURES. Development of seismic design methods for concrete dams and appurtenant structures.	Technical report, "Seismic Analysis of Intake Towers." ETL 1110-2-xxxx (draft), "Earthquake Analysis of Intake Towers." ETL 1110-2-xxxx (draft), "Earthquake Analysis and Design of Concrete Gravity Dams."
13. INTERACTIONS OF CONCRETE DAMS WITH FOUNDATIONS. Evaluation of the effects of foundation flexibility on the response of concrete structures to earthquakes. Combined with work unit under No. 12.	
14. MILITARY RDT&E PROGRAM (AT 22): EARTHQUAKE GROUND MOTIONS. Evaluation of the influence of geological site conditions and soil/rock properties on the characteristics of earthquake ground motions at the site.	Technical Report (GL-81-2, "Site Effects on Power Spectral Densities and Scaling Factors." Technical report, "A Study of the Engineering Characteristics of the 1971 San Fernando Earthquake Using Time-Domain Techniques."
15. FUNDED BY FIELD-OPERATING AGENCIES: STRONG-MOTION INSTRUMENTATION PROGRAM. Installation and maintenance of strong-motion accelerographs at CE projects; collection, processing, and publication of strong-motion records obtained during earthquakes.	Input to ER 1110-2-103. Input to EC 1110-2-xxx (annual). 300 accelerographs, 80 seismoscopes, and 27 peak recording accelerographs installed in 104 project locations in 34 states and one territory. The first strong-motion records representative of seismic activity in the New England area were obtained during the Franklin Falls, NH, earthquake of 18 January 1982.
16. FUNDED BY NUCLEAR REGULATORY COMMISSION: EARTHQUAKE-INDUCED SETTLEMENT. Investigation of characteristics of soils that contribute to volume changes under shaking, and development of methods of predict earthquake-induced settlements of structures founded on soils.	Technical report, "Current Methodologies for Assessing Seismically Induced Settlements in Soils." Proposed technical report to correlate undrained cyclic simple shear test results and undrained cyclic triaxial test results for use of the latter in the DESRA analysis.

DEPARTMENT OF THE NAVY

NAVAL FACILITIES ENGINEERING COMMAND
EARTHQUAKE SAFETY PROGRAM

PROJECT/WORK UNIT TITLE	MAJOR PRODUCTS
1. SCOPE OF RESEARCH: Develop means of reducing the vulnerability of the Naval Shore Establishment to earthquake damage. Develop improved estimates of risk, methodology for investigation of site hazards and structures, and economic analysis methods for evaluating mitigation projects.	1. R 847, An Earthquake Analysis of the Liquefaction Potential at the Naval Air Station, North Island, CA, Naval Civil Engineering Labatory. 2. Puget Sound Naval Shipyard: Dynamic Analysis, Rapid Evaluation Method, and Cost Estimates for Damage - John Blume Assoc., Sept. 1973. 3. TN - 51 - 76 - 01, Seismic Investigation Requirements for Naval Facility Projects at San Diego - A Preliminary Analysis, Oct 1977, Naval Civil Eng. Lab. 4. TN 51-78-02, Rapid Seismic Analysis Procedures, April 1978, Naval Civil Engineering Laboratory (NCEL). 5. TN M51-78-21, Computer Screening of Real Property Inventory for Seismic Investigation of Modernization Project at San Diego - A Premlinary Analysis, Oct 1977, NCEL. 6. Capital Investment for Mitigation of Risks from Natural Hazards - Methodology Report, N 00025-75-0-0014, 3 May 1977, John Wiggins Assoc. 7. TN 1579, Least Total Cost Analysis for Earthquake Design Levels, June 1980, NCEL. 8. Detailed Seismic Structural Analysis of Navy Buildings 335, 783, 14,678, 793, 306, 334 Naval Air Station, North Island, H.J. Degenkolb Assoc. Engrs., Jan. 1982. 9. Detailed Seismic Structural Analysis of Storehouse & Facilities Supply, Packing and Shipping Building 651, NAS North Island, CA, C.V. Cherepati & Assoc. Inc, Sept 1982. 10. Phase II, Earthquake Vulnerability Study of Selected Buildings at the Naval Shipyard, Charleston, SC, URS/John A. Blume & Assoc., Engrs., Aug 1982. 11. Seismic Safety Evaluation Buildings 34, 351, 372, and 513, U.S. Naval Pacific Test Center, Point Magu, CA, Martin & Saunders Inc., 23 June 1982. 12. Seismic Risk Study, David Grant Medical Center, Travis Air Force Base, Fairfield, CA, Kaplan/McLaughlin/Diaz, Architects/Planners, 29 June 1979. 13. Earthquake Safety Investigation, Naval Air Station Lemoore, CA (phase I), Sexton, Fitagerald & Kaplan, Engineers, Oct. 19, 1982. 14. Seismic Evaluation & Strengthing of Naval Regional Medical Center at Long Beach, CA (Phase II), Agbabian Assoc., July 1981. 15. Seismic Safety Inspection of the Public Works Center, San Diego, CA, Graham & Kellam Structural Engineers, Feb. 1979.

NAVAL FACILITIES ENGINEERING COMMAND
EARTHQUAKE SAFETY PROGRAM (CONTINUED)

PROJECT/WORK UNIT TITLE	* MAJOR PRODUCTS
* The reports list above are typical of the approximately 80 reports completed in connection with the Navy Earthquake Safety Program. Phase II, detailed analysis reports may deal with one building or many buildings (40 max.).	8. TM 1530, Seismic Liquefaction Potential, Sept 1978, NCEL. 9. TM 51-79-08, Revision to Program RECUR and An Example Case Study, Mar 1979, NCEL. 10. TM 51-79-08, Retrieval of USGS Strong Motion Earthquake Data, May 1979, NCEL. 11. TM 51-80-08, Earthquake Hazards Reduction Program, Naval Facilities, Guam, Marianas Islands - Site Response Spectra, April 1980, NCEL. 12. TM 51-81-03, Repair or Replacement of Shore Facilities, Mar 1981, NCEL. 13. TM (Draft), Analysis of Earthquake Design Levels, 1981, NCEL. 14. TM 1566, Seismic Liquefaction Studies, Dec 1980, NCEL. 15. TM 51-80-05, Evaluation of Earthquake Activated Gas Shutoff Valves, Mar. 1980, Naval Civil Engineering Laboratory. 16. R 885, Procedure for Conducting Site Seismicity Studies at Naval Shore Facilities and An Economic Analysis of Risk, Feb. 1981, NCEL. 17. TM 51-82-09, NAVFAC's Strong Motion Instrumentation Program, Nov. 1982, NCEL. 18. TM 51-82-10, Summary of Seismic Damage Estimate of Navy Building, Nov. 1982, Naval Civil Engineering Labatory. 19. TN N1555, Seismic Soil Liquefaction at the Waterfront, NCEL, May 1979. 20. TN 1566, Seismic Soil Liquefaction Studies, NCEL.
2. SCOPE OF INVESTIGATION: Investigate the earthquake safety of existing facilities. Determine degree of vulnerability, feasibility of mitigation of hazard, and cost. Investigation includes site hazards, utilities, structures, and life threatening non strucutral-components, as well as protection of critical or costly equipment.	1. Puget Sound Naval Shipyard: Preliminary Study, Static Analysis and Design Earthquake - John Blume Assoc., Sept. 1973. 2. Seismic Safety Investigation of Oakland Naval Hospital at Oakland, CA, John A. Blume & Assoc. Engrs., Nov. 1973. 3. Life Safety/Seismic Study for the Naval Regional Medical Center, Charleston, SC, URS/Blume, 1 Mar 1982. 4. Seismic Safety Investigation of Charleston Naval Hospital at Charleston, SC, John A, Blume & Assoc. Engrs., Nov. 1974 5. Summary Report, Least Cost Seismic Improvement of a Naval Hospital (Memphis, TN), EDAC, July 1981. 6. TM M-51 76 21, Earthquake Hazard Reduction Program North Island Naval Air Station, San Diego, Naval Civil Engineering Labatory, Dec. 1976. 7. TM M51 78 08, Earthquake Hazards Reduction Program North Island Naval Air Station, San Diego, NCE. April 1978..

Office of the
Administrator
of Veterans Affairs

Washington, D.C. 20420

Veterans
Administration

JANUARY 17 1983

Honorable Doug Walgren
Chairman
Subcommittee on Science,
Research and Technology
House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

In response to your request for information on the Veterans Administration's earthquake program activities, we are enclosing a copy of a report by R. D. McConnell, Director, Civil Engineering Service, Office of Construction, which summarizes those efforts.

In addition, we are enclosing a copy of VA's five-year construction plan for future seismic strengthening projects.

As to cooperation with other Federal Agencies' programs, VA has been active in Federal Emergency Management Agency efforts such as the Interagency Committee on Seismic Safety in Construction (and various subcommittees of that group) and the Interagency Coordinating Committee of the National Earthquake Hazards Reduction Program. VA is also active on engineering review committees of the National Bureau of Standards/FEMA directed Applied Technology Council program to produce national seismic design standards, and participates in the United States/Japan Panel on Wind and Seismic Effects.

The Director of Civil Engineering Service is the representative for Federal Agencies on the Board of Directors of the Building Seismic Safety Council (a division of the National Institute of Building Sciences).

We plan to continue such interagency activities in the future in addition to our own earthquake hazards reduction program. We thank you for your interest in these efforts. If we can be of further assistance, please contact us.

Sincerely,

Harry N. Walters

HARRY N. WALTERS
Administrator

Enclosures

VETERANS ADMINISTRATION SEISMIC CORRECTION PROGRAM

Richard D. McConnell*

Summary

Following the San Fernando Earthquake of February 9, 1971, when two patient occupied buildings of the Veterans Hospital at that site collapsed killing 46 persons, the VA was required to undertake a full seismic program. This program included the appointing of an Advisory Committee, preparation of a seismic code and a program to update all VA Facilities to prevent such a recurrence. To implement these directives, a program of site evaluations to determine the predictable seismic levels was undertaken at 68 hospital sites. Following the site evaluations, most of those sites were then investigated as to the adequacy of the structures at those locations to withstand the predicted level of possible seismic events. As a follow-up phase to the first building studies, a subset of the structures investigated, which had been found to be deficient, were studied as to alternate means for adequate hardening to bring them to the required seismic strength. In the years following that San Fernando Earthquake, VA has undertaken alterations to harden deficient structures at many of these sites. In addition, buildings were demolished or occupancy changed where deemed necessary. The VA Seismic Code Standard H-08-8 has been used for the past seven years for the design of all new hospital structures and is the criteria for all retrofit. An instrumentation program was introduced and studies were undertaken and requirements issued concerning nonstructural details; post-operational utility provisions; control of Furniture, Equipment and Supplies; and related studies such as masonry testing, soil stability, etc.

Introduction

The San Fernando Earthquake of February 9, 1971, destroyed or severely damaged four major hospitals, including two patient-occupied buildings of VAH, San Fernando, that collapsed, killing 46 persons. The VA buildings were designed and constructed prior to the development of seismic design codes. The other non-VA hospitals were of relatively recent construction and were designed to resist earthquake forces. None of those hospitals could be salvage.

A House of Representatives Subcommittee on VA Hospital Disaster held formal hearings on February 22, 1971 and received testimony from the Deputy Administrator, other VA officials familiar with the disaster, and several technical experts. In an Interim Report dated March 18, 1971, the Subcommittee made several recommendations. One key recommendation was the following:

> "The Veterans Administration should immediately identify all structures in the VA hospital system located in hazardous zones to determine what must be done to make them safe. If

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*Director, Civil Engineering Service, Veterans Administration, Washington, DC

> modernization of these facilities to meet latest seismic and other safety standards is not considered feasible, either replacement structures should be built or patients relocated in safe structures at other hospitals."

The Veterans Administration appointed a Committee of consultants who developed new requirements for earthquake resistant design of VA hospital facilities. In December 1973, an Advisory Committee on Structural Safety of VA Facilities was appointed, as required by Public Law 93-82, to recommend standards for fire, earthquake and other natural disaster-resistant construction. The Advisory Committee formally recommended the earthquake-resistant design requirements developed by the earlier Committee and they have been adopted.

VA Seismic Code

The Committee decided that the VA design code should be based on the Earthquake Regulations of the Uniform Building Code, but with some major modifications. Those UBC Earthquake Regulations are the most widely accepted such code in the country and are revised on a regular basis by the Seismology Committee of the Structural Engineers Association of California. The principal modifications we made were:

1) We are not using code level forces. We evaluate our sites for geologic and seismic hazards, and design new facilities to resist the strongest ground shaking that can be expected at the site. Existing structures were evaluated in terms of the maximum ground shaking that may reasonably be expected during the planned life of the facility.

2) The Uniform Building Code did not include at that time the effects of soils on earthquake motions, although, these effects may be important. We retained Professor Matthiesen, University of California at Los Angeles, (now with USGS), and Professor Scott, California Institute of Technology, to prepare short summaries of present knowledge in (a) amplification of strong ground motion due to soil layering, (b) soil structure interaction, (c) soil liquefaction, and (d) slope stability and the design of retaining walls.

3) Considered ductility/damping factors for different types of structures.

4) Modal method dynamic analysis for certain classes of structures.

5) The Uniform Building Code required reinforcing of all masonry that resists seismic forces. This is quite reasonable for the West Coast areas where both the level of ground shaking and the frequency of earthquakes are high. However, masonry in the great majority of existing VA structures in other areas of the country was not reinforced. We asked the Bureau of Standards to: (a) investigate tests of failure of masonry induced by earthquake loading, and (b) propose test methods for determining the strength and stiffness properties of existing masonry. Out of this, we hoped to develop

safe lower bounds of masonry strength that could be used to evaluate our existing structures realistically.

Masonry Testing

In the beginning of the masonry testing program, sampling and testing of the wall specimens were conducted generally in accordance with the National Bureau of Standards recommendations. This entailed cutting a wallette approximately 1-1/2 foot square out of the existing building walls and testing by applying a compressive load across the diagonal. The cost per sample was approximately $2,000 including the sample cutting, testing and patching of the hole. It should also be mentioned that such an operation almost necessarily causes some disruption in hospital operations.

It was decided that something less expensive and less disruptive was necessary. For this we turned to cylinder cores taken from the walls. A problem is encountered here because the results of cylinder tests do not quite correlate with the resultls of wallette tests.

Testing Engineers, Inc. undertook to examine this problem. In the test program which was run by Mr. F. R. Preece, shear strength values were obtained from wallette samples and from cylindrical core samples. Mr. Preece found that close agreement between the two methods was reached by including the influence of internal friction.

The cylinder core sample has two big advantages over the wallette type sample. First, the cylinder core costs only approximately $200 per sample versus the approximately $2,000 cost per wallete sample. Second, a cylinder core can be taken and the hole repaired relatively quickly, with a minimum of disruption of hospital functions, whereas cutting and replacing a wallette sample is disruptive.

The values of ultimate tensile and shear stresses are translated into allowable stresses (via the NBS approach, which has been incorporated as part of the VA's Standard H-08-8). These allowable stresses then determine whether an existing wall must be reinforced or whether it is a viable structural element (shear wall) which is capable of resisting shear forces.

The results of the Veterans Administration program of testing wall cores, to no one's surprise, can be characterized as extremely varied. Shear ultimates ran from almost zero to well over 300 psi. These included sample results from brick, concrete block and clay tile. The samples were from all over the country and represent almost the full range of age and workmanship that can be found in unreinforced masonry.

During the progress of the seismic program, the VA has found that walls that might look at first to have no strength and thus no influence on building reaction to earthquake forces are, in fact, quite strong and therefore constitute major load paths.

The VA also found that even when the walls are understrength, a strengthening procedure that has come to be known as the Boise method (building another wall on the outside of the old one) can economically ($15 to $30/ft.2) strenthen old buildings.

Program Description

Sixty-eight of the existing VA Hospitals are in geographical areas where moderate or major earthquakes have occurred. Most of the 68 hospitals have some unreinforced masonry. The buildings in these hospital centers range in age from 6 or 8 years old to well over 70 years. The total money investment is in the billions of dollars and, of course, the replacement cost would be many times the original cost. Consultants were retained to study the seismic and geologic hazards at each site. These reports were reviewed by the U. S. Geological Survey and NOAA to confirm the evaluation of the seismic risk. It was decided that the deficient VA hospitals would be strengthened to withstand any earthquake that might be expected in their areas in the next 100 years. This involved a structural evaluation of many of the 68 hospitals, and each hospital usually has many buildings. Other consultants evaluated the ability of the buildings to withstand earthquake forces and provided alternate procedures with corresponding cost estimates for those buildings found to be in need of strengthening.

All substandard buildings essential to the operation of medical centers in areas of high seismicity have been or will be corrected as necessary. Some have been demolished. It was decided that, in areas of moderate seismicity, only substandard bed patient buildings would be corrected. Also, correction of nonstructural deficiencies that present potential life hazards or threats to facility operations would be included in these projects.

Seismic construction projects have been programmed along with other necessary corrections to maintain a balanced annual construction program within available resources and consistent with other system-wide priorities.

In addition to basic design standards, the VA has developed seismic requirements for utility services, architectural components, and equipment and furniture.

The Veterans Administration has had a Strong Motion Instrument Program for ten years. This program involved the purchase of 66 instruments which were placed at 56 stations around the entire country. These instruments were installed by NOAA and USGS and maintenance is funded by the VA and performed by USGS. It is interesting to note in this regard that the Jan. 24, 1980 Livermore earthquake which sustained significant damage in facilities other than Veterans Administration had only one set of instrument records which could be used for post-analysis. These records were obtained at the Veterans Administration Hospital at Livermore. Those records, incidentally, showed peak values of .17g at the basement level and .64 at the roof level.

Accomplishments to Date

The most serious problems encountered by the VA were in California. It was evident after receiving reports on the condition of the buildings and the cost of required reinforcement that the agency had no choice but to evacuate potentially hazardous facilities at Wadsworth, Menlo Park, and Livermore. A large percentage of buildings at these West Coast Hospitals were constructed before 1935, when no seismic design requirements were in general use, and were found to be unable to withstand earthquakes if high intensity. The inspection of all 22 buildings at the San Francisco hospital indicated no need for relocation of patients, although minor alterations would be made in some of the buildings, and the boiler house was relocated.

Of the 82 buildings at Menlo Park Division of the Palo Alto Hospital, 18 were deemed structurally unsatisfactory in event of a major earthquake in the area. But of those 18, only one was actually occupied by patients.

At Livermore, 13 of the 48 buildings were pinpointed as potentially hazardous, including the largest patient-occupied building on the station.

Of the 236 buildings at the West Los Angeles complex, 30 were graded potentially hazardous, including eight patient-occupied structures.

The remaining four VA hospitals in California -- as well as the Palo Alto Division of the two-hospital operation at Palo Alto -- are of more recent construction, and were judged to be of satisfactory seismic construction. However, a new review of some buildings at these sites is now in progress.

In the face of such circumstances, the VA acted immediately to vacate the weaker buildings and to start the improvement of those which had to be continued in service. An extensive program was necessary to relocate patients and staff from the weaker existing buildings to new and converted facilities at a number of other hospitals. Replacement hospitals at Los Angeles and Loma Linda provide modern facilities for those destroyed by the earthquake or evacuated because of structural weaknesses. Another major building to replace seismically deficient units is programmed for Palo Alto. Evaluation and strengthening of other facilities is continuing where necessary.

To this date, the Veterans Administration has spent more than 250 million dollars in the total seismic correction program including site studies (site prediction and review of buildings), demolition, structural and non-structural hardening, temporary facilities and procedures for the post-earthquake California relocation plan, and three replacement hospitals.

The Veterans Administration Program for seismic deficient facilities is confronted with numerous concerns and problems which may not be evident to all at first. One of these is the requirements by Historical Preservation Groups at various government levels. This has been most significant in correction programs which have involved modifications to exterior walls at a number of our sites.

Another major concern is disruption. This becomes a severe problem for VA hospitals where occupancy and functions must be sustained.

More recently, and in direct response to geologic evidence that a major earthquake has a better than 50% probability of occurring within the next decade, the VA has begun programs to: (1) anchor major mechanical and electrical equipment so it will not be dislodged and disrupted during an earth-quake; (2) install an emergency radio network to facilitate direct communication between any VA facility in California and any other in the United States; (3) provide for emergency utilities, especially water and electrical power, in all VA medical centers; (4) provide heliports at all existing medical centers for emergency use; (5) install special earthquake provisions for equipment, furniture, and supplies to assure that VA Medical Centers can function as a community resource in the post-earthquake period; and (6) conduct earthquake drills.

Examples

The following two page Table presents a recap of 13 stations which are recent projects for seismic hardening under design or construction. This Table indicates the munber of buildings, cost, the current status and a brief statement of the method of hardening projects. Selected details for 6 of these sites follows. The purpose of these details is not primarily to show specifics such as dimensions in all cases, but to present the variations of types of hardening used and also provide a qualitative description, by way of the details, to indicate some of the problems and how they are resolved.

In general, two of the stations, Boise and Salt Lake City principally used what we now classify as the "Boise Method" in that the exterior shear walls are new concrete placed on the outside of the existing exterior wall and new face brick placed on that concrete.

In contrast the shear walls on Charleston on the exterior are to have shotcrete and shaping such that the concrete will be exposed.

On American Lake and Walla Walla, most of the shear walls were exterior shotcrete applied and essentially left without face brick.

Prescott was distinct in that it used 4" shotcrete on the inside of the exterior masonry walls due to Historic Preservation objections to any exterior alterations.

Fort Harrison used interior reinforced concrete shear walls.

Fresno will use a combination of interior steel K bracing, concrete and steel shear walls as well as some exterior shear walls. In addition to these generalizations, there were some variations of interior/exterior types in various projects.

It should be pointed out that in all cases every effort was made to minimize disruption by accounting for the lateral strength required by incorporating as few interior shear walls as possible in the plan. Most of these western stations had difficulties meeting historical preservation requirements in regard to finish.

It can be noted on the Salt Lake City and Boise details that the so called "Boise Method" incorporated the use of shear keys imbedded into the existing masonry in conjunction with reinforcing ties to both the existing masonry and the new outside wythe.

Originally at Salt Lake City, the intention was to peel away the outer face brick and then proceed with the concrete shear portion and a new outer wythe. It was found however, that there were two problems. One was the substantial bond in the masonry and the second was the factor of height of some of the buildings.

The Ft. Harrison details show a means of adding stiffness to the columns and also indicate the steel bracing.

The detail for the exterior walls on American Lake shows the type of "Key Pocket" as it is called and also shows the outside stuco plaster finish on top of the concrete shear portion.

The details of Prescott are uniquely interesting because that was timber existing construction.

Although there are no details for it shown in this section, the hardening at West Roxbury Center is distinct in contrast to the examples shown here in that it provides new wings which will be stitched to the existing buildings thereby buttressing the entire combined unit for lateral forces.

For the Charleston project, steel cross bracing and the use of end towers were dismissed for various reasons and, ultimately, four types of shear walls were developed: one story reinforced concrete shear walls in the pipe basement; exterior reinforced concrete shear walls; interior reinforced concrete shear walls; and interior steel shear panels.

As is noted in Figures 7 and 10, walls above the third floor in the longitudinal direction are exterior reinforced concrete while those in the transverse direction are interior steel shear panels. Below the third floor, the exterior walls become interior reinforced shear walls on the South side.

Figure 8 shows a transverse section through the building after new shear walls will be added. In contrast to the "Boise Method", on this project, the outside brick and insulation are to be removed before installation of the concrete shear wall.

Figure 9 shows a typical cross section of the existing and modified exterior wall. The use of the steel shear panels was to minimize construction disturbances, they either to be built in place or prefabricated as units and connected in place. Since they are to be located against existing walls, these new steel shear panels were designed so that all welded connections are to be made on one side only.

Figures 11 and 12 show the steel walls.

The following hardening costs are on a square foot of gross area basis and are indexed to April 1981 dollars:

Boise	$22 psf
Salt Lake City - Bldgs. 1 thru 5	$15.30
Salt Lake City - Bldgs. 6 thru 9, 27 & 28	$19.60
Charleston	$22.32

The cost per square foot of wall area on Salt Lake City, Buildings 1 through 5, (indexed to April 1981) was $17.70.

Acknowledgements

The author would like to thank Mr. Mohammad Ayub, Structural Engineer with the Veterans Administration for his assistance in the preparation of this paper. Also, he would like to thank Mr. Joseph Baldelli of the firm of John A. Blume and Associates for his willingness to permit the use of some of his sketches of the Charleston project to be used in this paper.

SEISMIC PROJECTS UNDER DESIGN OR CONSTRUCTION OR COMPLETED

May 6, 1981
Page#1

STATION	g	PROJECT#	BLDG.NOS	COST		PROJ.STATUS	METHOD OF HARDENING
				Estimate	Bid		
AMERICAN LAKE, WA	0.2g	505-042	4		926,600	Construction Complete November '77	Use of 4"-5" shotcrete on outside of masonry wall
AMERICAN LAKE, WA	0.2	505-063	5	$1,400,000		*WD Complete	Use of 4"-5" shotcrete on outside of masonry wall plus some interior concrete shearwall.
AMERICAN LAKE, WA	0.2	505-053	7		$500,000 (Approx.)	*Construction Complete	Use of 4"shotcrete on outside of exterior masonry walls
BOISE, ID	0.15	513-032	13,67,27, 77,34,2, 28,29,8,79		$2,391,373	Construction Complete December '76	Exterior conc.shear walls on perimete of bldg.plus new fascia brick
CHARLESTON, SC	0.25	534-016	1		$8,584,000	*Construction in Progress	Exterior conc. shear walls on perimeter of bldg plus some interior conc. & steel shear walls
FT. HARRISON, MT	0.30	436-038	16,43,47, 141,142, 150		$1,249,100	Construction Complete April '80 -(Station Level)	Interior conc. or reinforced masonry shear walls
FRESNO, CA	0.23	570-016	1,3,10,11		$4,055,800	*Construction in Progress	Interior steel K bracing & some exterior shear wall at selected bays
LOS ANGELES, CA	0.25	691-093	113	$ 800,000		*Construction Complete	Exterior gunite shear walls at perimeter of bldg.

NOTE: "Construction Complete" indicates substantial completion in accordance with base bid.

*Revised 12/20/82

SEISMIC PROJECTS UNDER DESIGN OR CONSTRUCTION OR COMPLETED

May 6, 1981
Page 2

STATION	g	PROJECT#	BLDG.NOS.	COST Seismic	 S&I	PROJ.STATUS	METHOD OF HARDENING
OKLAHOMA CITY, OK	0.10	635-010	1a,1b,1c,1d		$17,000,000 incl. other work	*Under Construction	Exterior conc.shear wall at selected bays only plus new facia brick
POPLAR BLUFF, MO	0.25	647-010	1,3,4,5		$6,000,000	*Construction in Progress	Exterior concrete shearwalls at perimeter plus new brick
PRESCOTT, AZ	0.15	649-048	13,17,19,20,42		$ 600,000	Construction Complete (Station Level)	Use of 4" shotcrete on inside of exterior masonry walls. Some interior shear walls too.
SALT LAKE CITY, UT	0.30	660-010	1,2,3,4,5		$6,413,630	Construction Complete October '79	Exterior conc.shear walls on perimeter of bldg plus new facia brick
SALT LAKE CITY, UT	0.30	660-028	6,7,8,9,10,11,27,28		$2,300,630	Construction Complete April '79	Exterior conc.shear walls on perimeter of bldg plus new facia brick
SAN FRANCISCO, CA	0.20	662-037	2	$1,200,000 (Approx)		*Working Drawings in Progress	Interior shearwalls plus strengthening of diaphragm & spandrel beams
WALLA WALLA, WA	0.15	687-040	68, 84		$ 312,000	*Construction Complete	Exterior conc.shear walls(partial) at a few selected bay & interior conc. shear walls
WEST ROXBURY, MA	0.10	523-125	1		$16,327,000	*Construction in Progress	Addition of 4 conc. shear towers & some exterior shear walls. Stitched existing expansion joints.

SEISMIC PROJECTS UNDER DESIGN OR CONSTRUCTION OR COMPLETED

STATION	g	PROJECT#	BLDG.NOS.	COST		PROJ. STATUS	METHOD OF HARDENING
				ESTIMATED	BID		
AMERICAN LAKE, WA	0.20	505-073	19	$3,200,000		Conceptual in Progress	
AMERICAN LAKE, WA	0.20	505-064	81	$ 420,000		WD Complete (Station Level)	
BATAVIA, NY	0.20	513-032	1	$21,000,000 incl. other work		Comprehensive Facility Study Underway	
BIRMINGHAM, AL	0.11	521-024	1	$55,300,000 incl. other work		WD in Progress	
BOSTON, MA	0.10	523-024	1,1A	$60,000,000 incl. other work		A/E to start Conceptual Soon	
BROCKTON, MA	0.10	525-010	2,7	$24,000,000 incl. other work		Preliminary Complete	
BROCKTON, MA	0.10	525-031	5	$ 9,200,000 incl. other work		Preliminary in Progress	
BROCKTON, MA	0.10	525-021	8	$11,000,000 incl. other work		Preliminary in Progress	
LIVERMORE, CA	.25		6			Construction Complete	

12-20-82

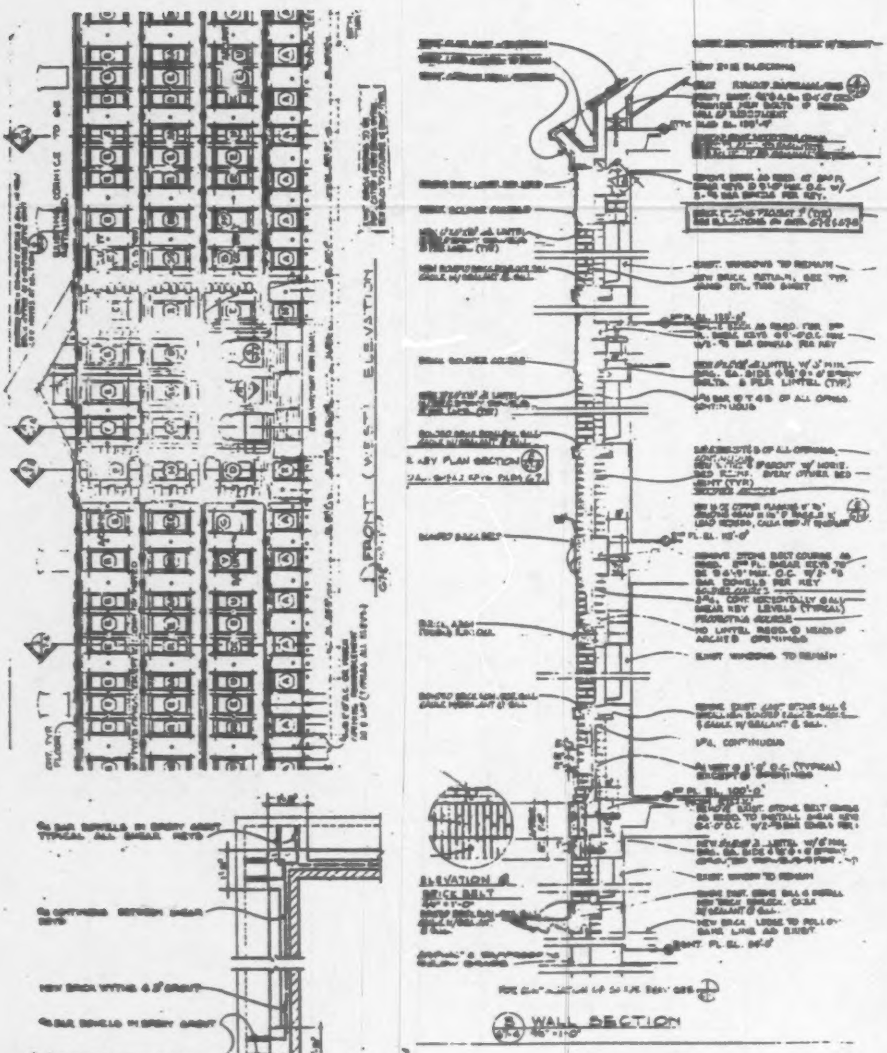
SEISMIC PROJECTS UNDER DESIGN OR CONSTRUCTION OR COMPLETED

STATION	g	PROJECT#	BLDG.NOS.	Cost Estimate	 Bid	PROJ.STATION	METHOD OF HARDENING
LOS ANGELES, CA	.25	530-032	209		$ 2,380,000 incl. other work	Construction in Progress	Minor Corrections
LOS ANGELES, CA	.25	691-086	215	$ 6,000,000 incl. other work		WD Complete	Minor Corrections
LOS ANGELES, CA	.25	691-098	213	$ 8,000,000 incl. other work		Preliminary Complete	Minor Corrections
MARION, IL	0.11	609-021	1,2,2A,2C 8,13,14,15, 16,Water Tower	$18,500,000		Preliminary in Progress	
ROSEBURG, OR	.08	653-029	2	$10,000,000 incl. other work		A/E selected for Preliminary	
SEATTLE, WA	.20	663-F14	1	$20,537,000		WD in Progress	
TOGUS, ME	0.10	402-054	207		$ 2,090,000	Construction in Progress	

12-20-82

NON-STRUCTURAL SEISMIC PROJECTS UNDER DESIGN OR CONSTRUCTION OR COMPLETED December 12, 1980
ALL ARE STATION-LEVEL PROJECTS

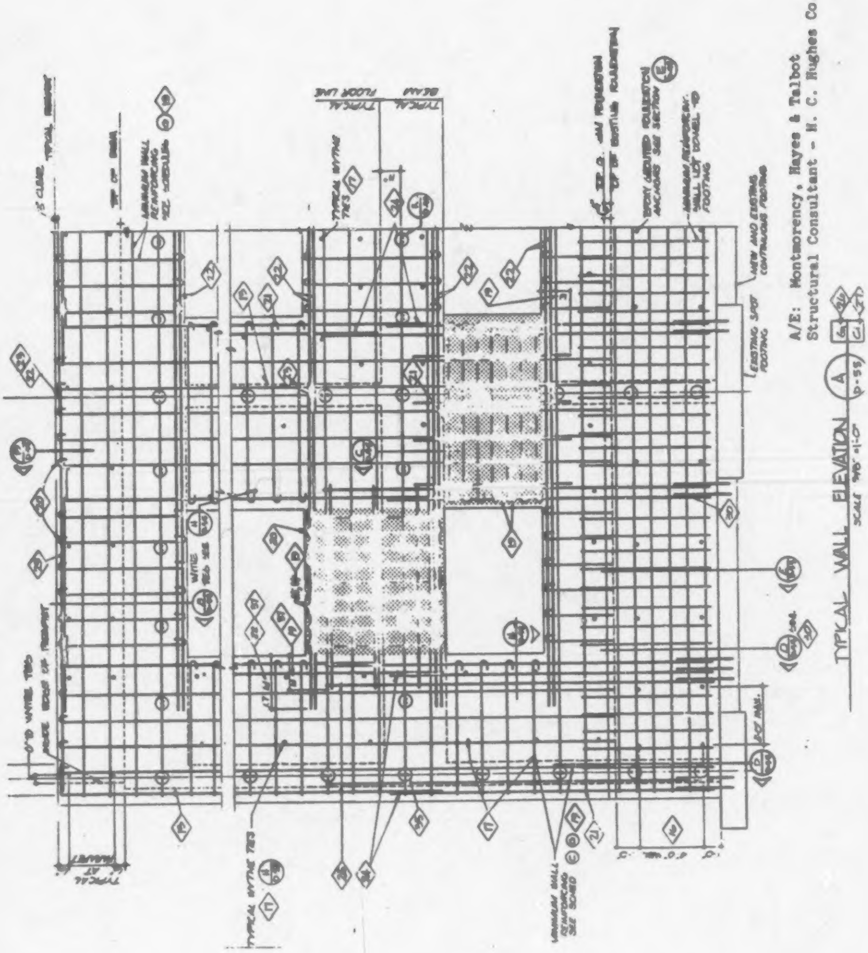
STATION	G	PROJECT#		COST Estimate	 Bid	PROJECT STATUS
LIVERMORE, CA	.25	599-049			$87,784	Construction contract awarded on 9/80
LONG BEACH	.39	600-045		$730,000		Scheduled for construction award on 12/1980
MARTINEZ, CA	.48	612-011			$ 61,841	Construction contract awarded on 9/30/80
MENLO PARK, CA	. 4	640-AO-064			$192,635	Construction contract awarded on 7/80
PALO ALTO(PAD),CA	. 5	640-034			$ 76,855	Construction contract awarded on 7/80
PALO ALTO(PAD),CA	. 5	640-064			$192,635	Construction contract awarded on 7/80
RENO, NV	. 5	654-032		$500,000		Scheduled for construction award on 12/80
SAN DIEGO, CA	.15	664-031			$598,000	Construction contract awarded on 9/79
SAN FRANCISCO, CA	. 3	662-042		$300,000		Not Scheduled until 4/83
SEPULVEDA, CA	.45	665-031			$189,700	Construction contract awarded on 8/80


FRONT (WEST) ELEVATION
TYPICAL PLAN SECTION
WALL SECTION
ELEVATION @ BRICK BELT
EXIST. WINDOWS TO REMAIN
NEW BRICK WYTHE & 2" GROUT

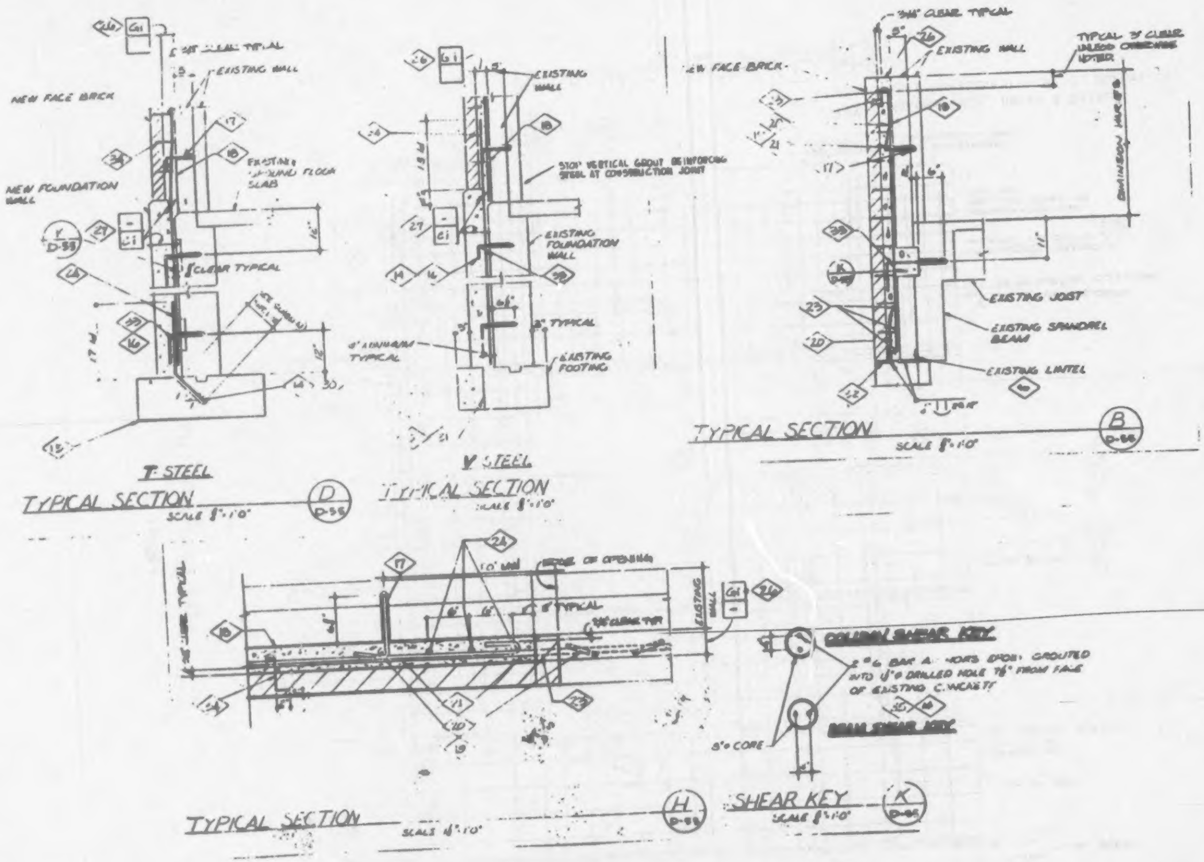
BOISE, ID

Figure 1

Walter Kidde Constructors, Inc.,
Englewood, Colorado

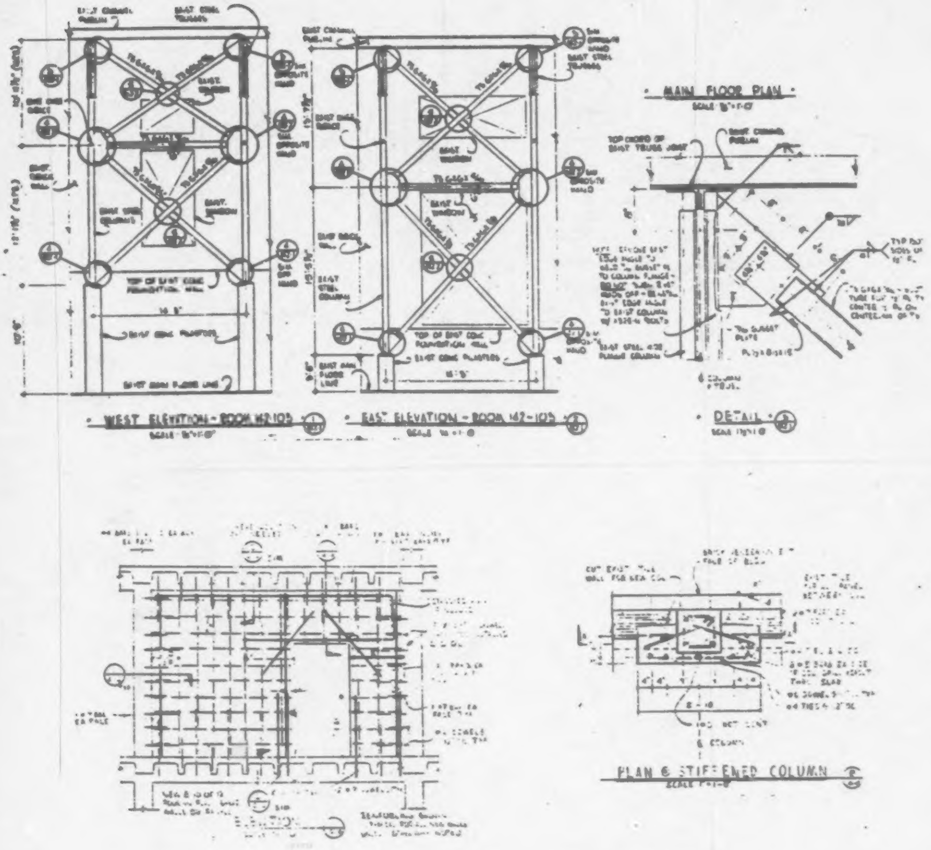

TYPICAL WALL ELEVATION
SCALE 3/16" = 1'-0"
A/E: Montmorency, Hayes & Talbot
Structural Consultant - H. C. Hughes Co.
TYPICAL FLOOR LINE
TYPICAL BEAM
EXISTING SPOT FOOTING
NEW AND EXISTING CONTINUOUS FOOTING

SALT LAKE CITY, UT
Figure 2


NEW FACE BRICK
EXISTING WALL
NEW FOUNDATION WALL
EXISTING GROUND FLOOR SLAB
CLEAR TYPICAL
T-STEEL
TYPICAL SECTION
SCALE
D
D-55
EXISTING WALL
STOP VERTICAL GROUT REINFORCING STEEL AT CONSTRUCTION JOINT
EXISTING FOUNDATION WALL
TYPICAL
EXISTING FOOTING
V STEEL
TYPICAL SECTION
SCALE
CLEAR TYPICAL
EXISTING WALL
TYPICAL 3" CLEAR UNLESS OTHERWISE NOTED
NEW FACE BRICK
EXISTING JOIST
EXISTING SPANDREL BEAM
EXISTING LINTEL
TYPICAL SECTION
SCALE
B
D-56
EDGE OF OPENING
TYPICAL
EXISTING WALL
COLUMN SHEAR KEY
BEAM SHEAR KEY
8" CORE
TYPICAL SECTION
SCALE
H
D-55
SHEAR KEY
SCALE
K
D-56

SALT LAKE CITY, UT

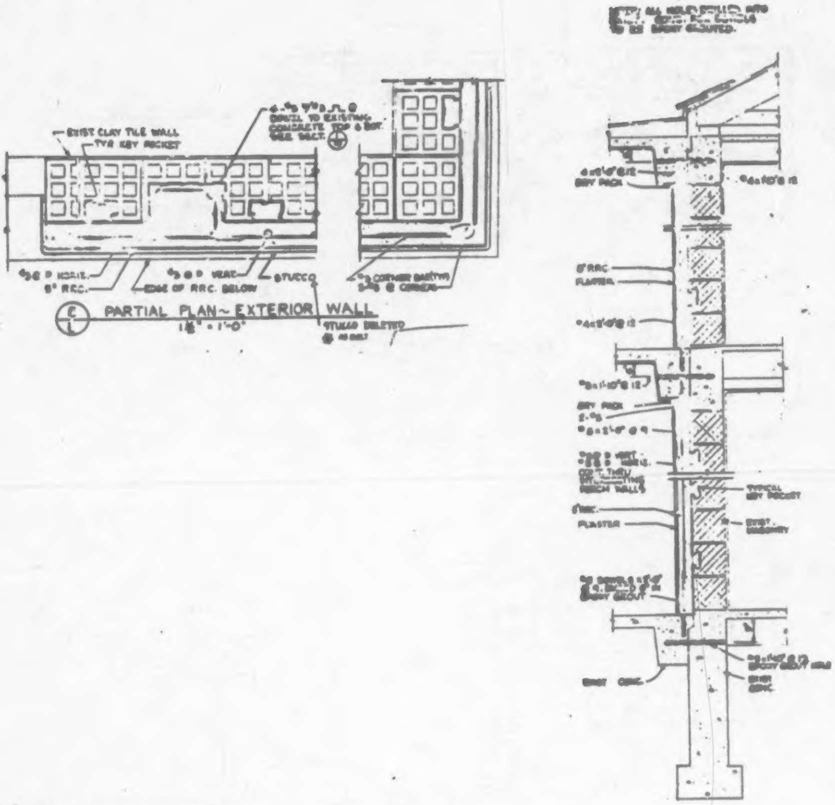
Figure 3


WEST ELEVATION - ROOM 112-105
EAST ELEVATION - ROOM 142-105
MAIN FLOOR PLAN
DETAIL
PLAN @ STIFFENED COLUMN
ELEVATION

A/E: Grossman Whitney Griffin
Structural Consultant: URS/John A. Blume & Assoc.

FORT HARRISON, MT

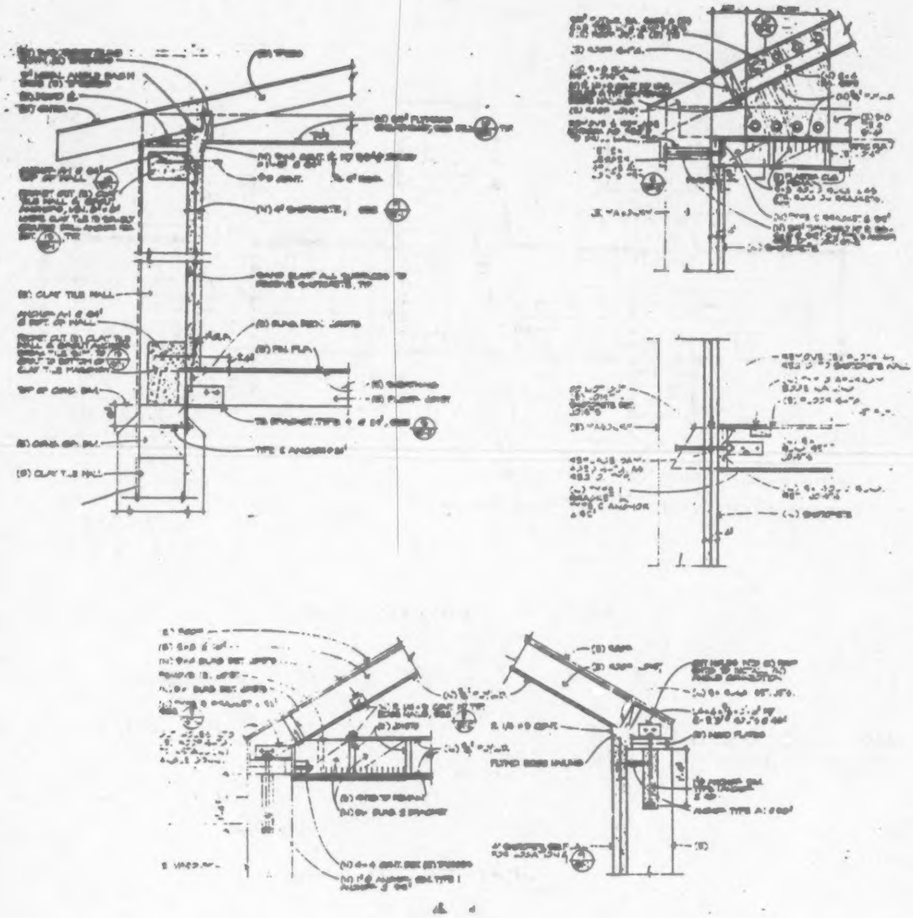
Figure 4


EXIST CLAY TILE WALL
TYP KEY POCKET
DOWEL TO EXISTING CONCRETE TOP & BOT. SEE SECT.
8" R.C.C.
EDGE OF R.R.C. BELOW
STUCCO
CORNER BARS (TYP)
PARTIAL PLAN ~ EXTERIOR WALL
STUCCO DELETED
EXIST CONC.
8" RRC
PLASTER
DRY PACK
TYPICAL KEY POCKET
EXIST. MASONRY
DRY GROUT
EPOXY GROUT
PLASTER

A/E: The Richardson Associates, Seattle, WA

AMERICAN LAKE, WA

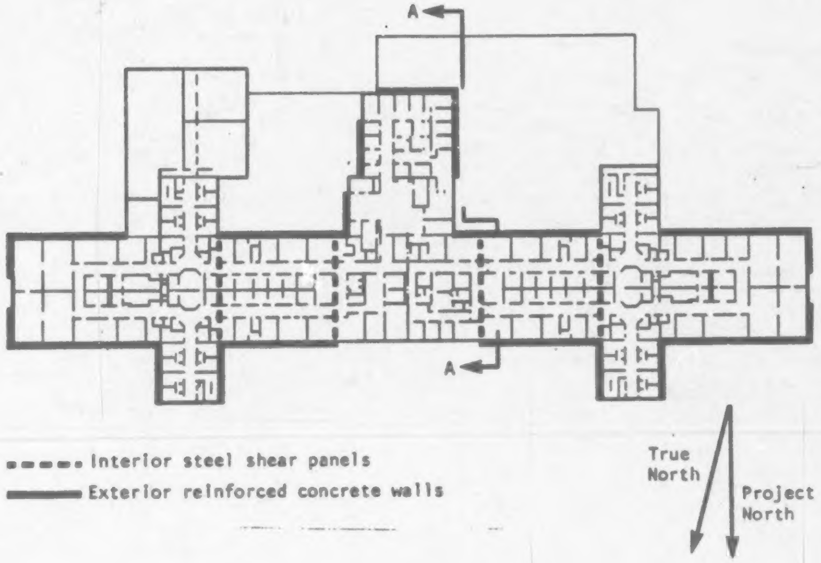
Figure 5



Structural Consultant: Holben & Martin, Tucson, AZ.

PRESCOTT, AZ

Figure 6

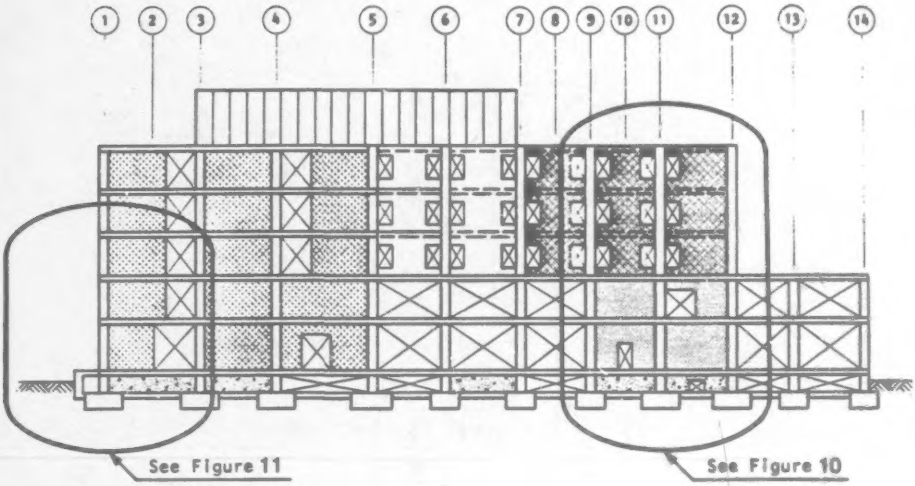

A
A
Interior steel shear panels
Exterior reinforced concrete walls
True North
Project North

THIRD-FLOOR PLAN

A/E: Lafaye Associates
Structural Consultant: John A. Blume

CHARLESTON, SC

Figure 7


①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
⑬
⑭
See Figure 11
See Figure 10

▨ Basement walls

▨ Interior reinforced concrete walls

▨ Interior steel shear panels

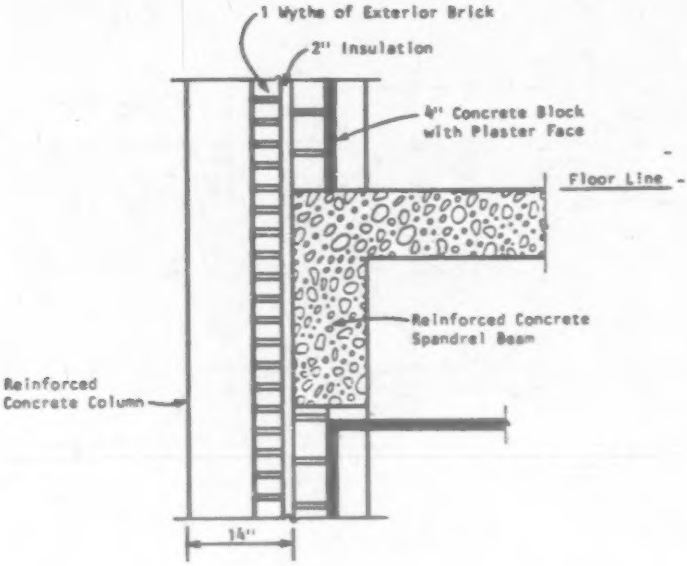
▨ Exterior reinforced concrete walls

② Computer column line

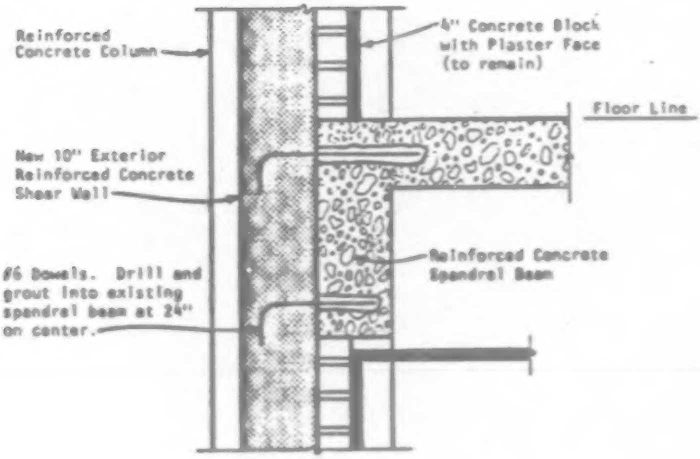
SECTION A, COMPUTER MODEL WITH NEW SHEAR WALLS

CHARLESTON, SC

Figure 8


1 Wythe of Exterior Brick
2" Insulation
4" Concrete Block with Plaster Face
Floor Line
Reinforced Concrete Spandrel Beam
Reinforced Concrete Column
14"

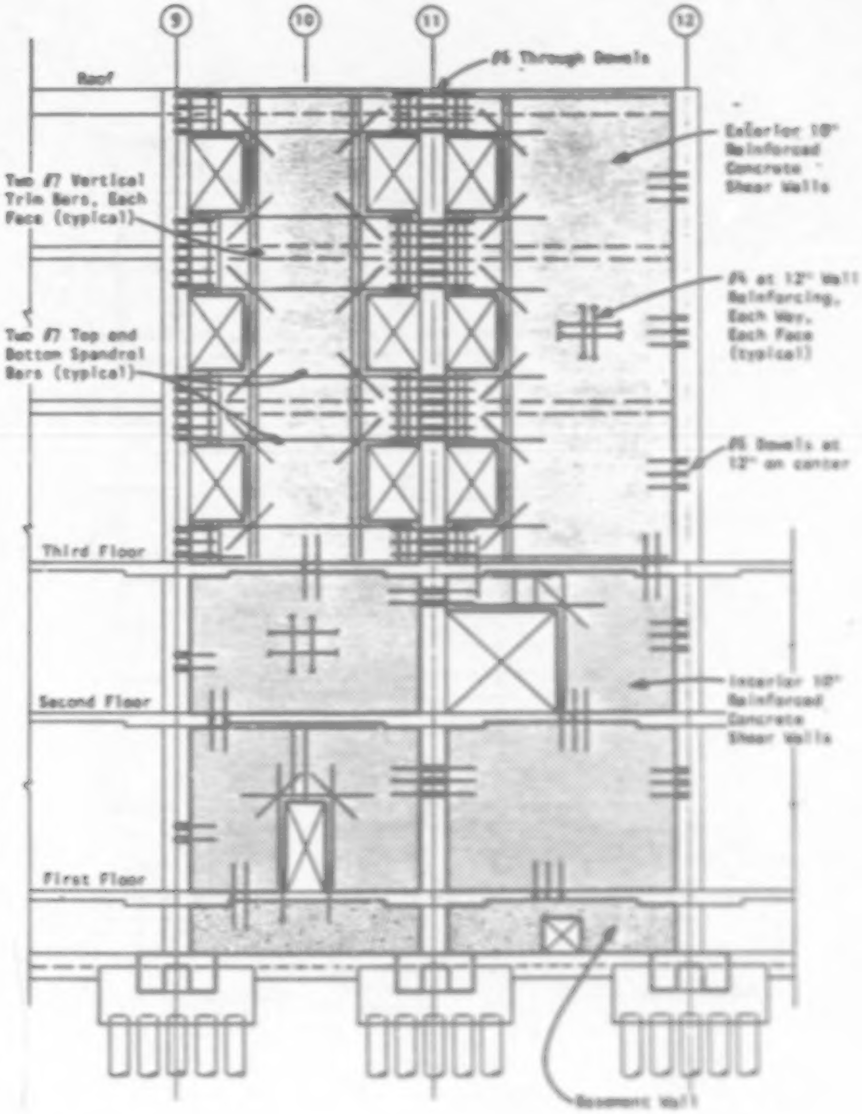
a. Existing Condition


Reinforced Concrete Column
4" Concrete Block with Plaster Face (to remain)
Floor Line
New 10" Exterior Reinforced Concrete Shear Wall
#6 Dowels. Drill and grout into existing spandrel beam at 24" on center.
Reinforced Concrete Spandrel Beam

b. Modified Condition

SECTION THROUGH EXTERIOR WALL

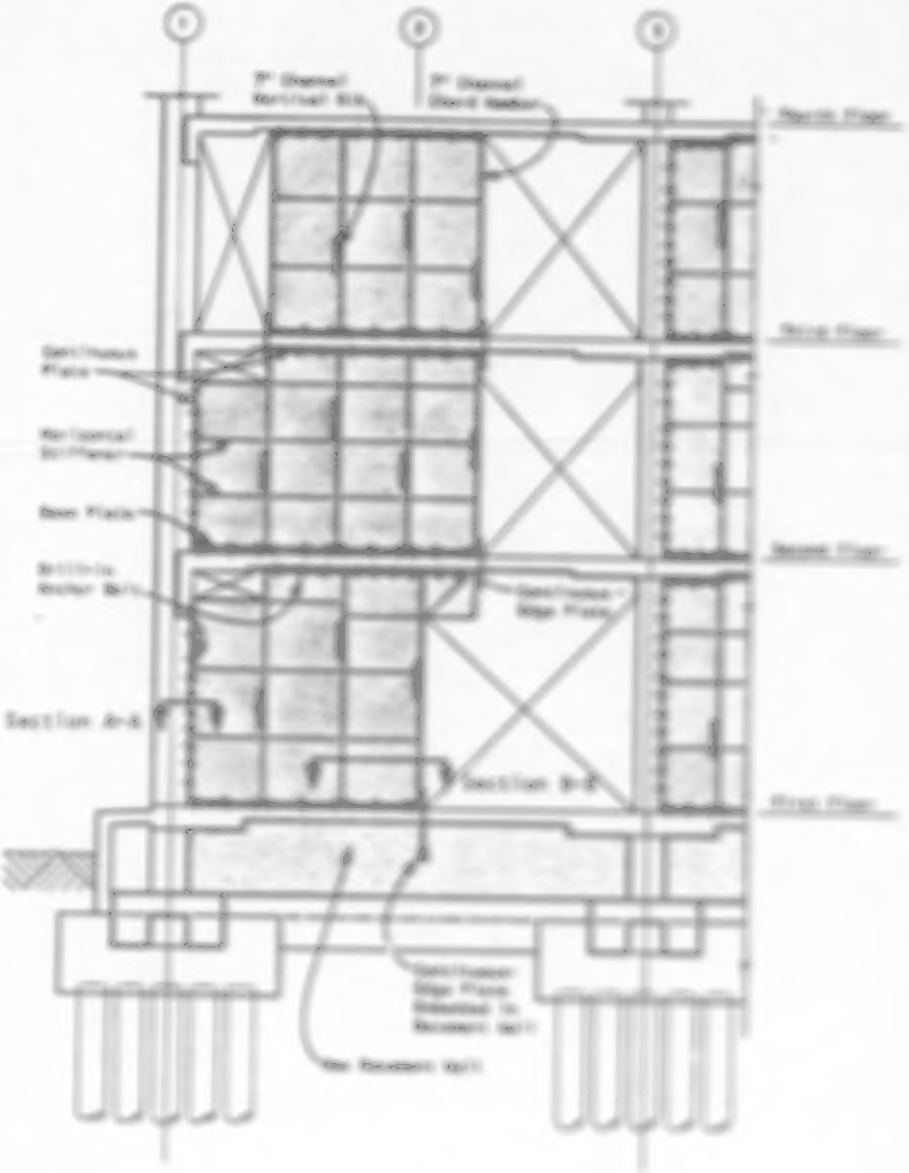
Figure 9 CHARLESTON, SC


9
10
11
12
#5 Through Dowels
Roof
Exterior 10" Reinforced Concrete Shear Walls
Two #7 Vertical Trim Bars, Each Face (typical)
#4 at 12" Wall Reinforcing, Each Way, Each Face (typical)
Two #7 Top and Bottom Spandrel Bars (typical)
#5 Dowels at 12" on center
Third Floor
Second Floor
Interior 10" Reinforced Concrete Shear Walls
First Floor
Basement Wall

WALL ELEVATION

CHARLESTON, SC

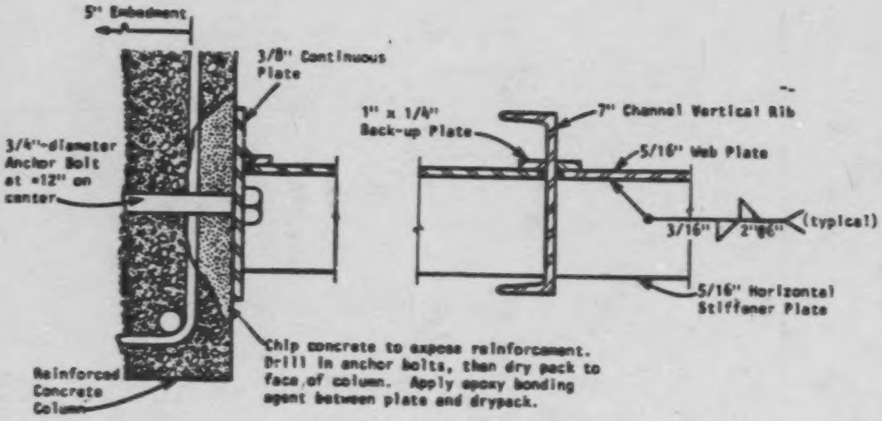
Figure 10


7" Channel Vertical Rib
7" Channel Chord Member
Fourth Floor
Third Floor
Continuous Plate
Horizontal Stiffener
Base Plate
Drill-in Anchor Bolt
Continuous Edge Plate
Second Floor
Section A-A
Section B-B
First Floor
Continuous Edge Plate Embedded in Basement Wall
New Basement Wall

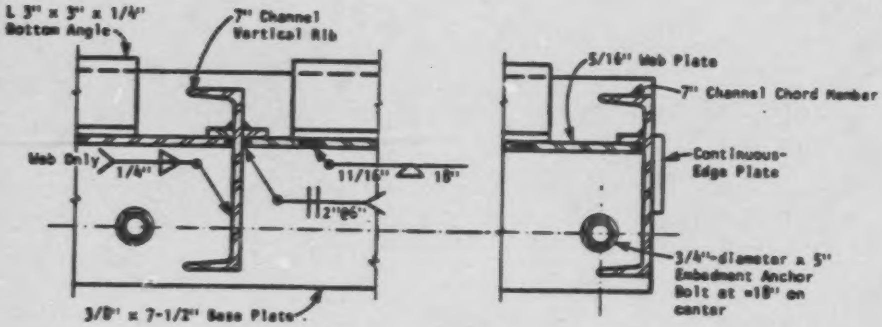
ELEVATION OF STEEL SHEAR PANELS

CHARLESTON, SC

Figure 11


5" Embedment
A
3/8" Continuous Plate
1" x 1/4" Back-up Plate
7" Channel Vertical Rib
5/16" Web Plate
3/4"-diameter Anchor Bolt at ≈12" on center
3/16"
2"@6"
(typical)
5/16" Horizontal Stiffener Plate
Chip concrete to expose reinforcement. Drill in anchor bolts, then dry pack to face of column. Apply epoxy bonding agent between plate and drypack.
Reinforced Concrete Column

a. Section A-A


L 3" x 3" x 1/4" Bottom Angle
7" Channel Vertical Rib
5/16" Web Plate
7" Channel Chord Member
Web Only
1/4"
11/16"
18"
2"@6"
Continuous-Edge Plate
3/4"-diameter x 5" Embedment Anchor Bolt at ≈18" on center
3/8" x 7-1/2" Base Plate

b. Section B-B

STRUCTURAL DETAILS OF THE STEEL SHEAR PANELS

CHARLESTON, SC

Figure 12

(1,000$)	FY 82	FY 83	FY 84 Levels A	FY 84 Levels B	FY 85 Levels A	FY 85 Levels B	FY 86 Levels A	FY 86 Levels B	FY 87 Levels A	FY 87 Levels B
Objective 6 - Medical Facilities Construction for Seismic Deficiencies										
Tasks:										
a. Palo Alto, CA	27,185									
b. Marion, IL					18,500					
c. Batavia, NY					21,000					
d. Los Angeles, CA					12,000					
e. Memphis, TN					24,300					
f. Prescott, AZ					33,000					
g. St. Louis, MO							16,000			
h. San Diego, CA							7,500			
i. Atlanta, GA									4,000	
j. Brockton, MA									33,000	
k. Columbia, SC									8,400	
l. Northampton, MA *									54,100	
m. Togus, ME									20,500	
Objective Totals	27,185	0	0		108,800		23,500		120,000	

*Includes some patient privacy construction

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
WASHINGTON, D.C. 20410

ASSISTANT SECRETARY FOR
POLICY DEVELOPMENT AND RESEARCH

IN REPLY REFER TO:

10 JAN 1983

Honorable Doug Walgren
Chairman, Subcommittee on Science,
Research and Technology
Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Walgren:

Secretary Pierce has asked me to respond to your letter of December 8, 1982, requesting information on this Department's research studies and other activities addressing the problem of earthquake hazards.

HUD's earthquake studies have been directed to identifying hazards and developing methods to reduce the potential for earthquake damage to housing; we have not looked at the more fundamental problems of earthquake physics or prediction. Our studies of earthquake hazards began over ten years ago. Two major series of reports were developed in this program, one with the general title of *A Methodology for Seismic Design of Single Family Dwellings*, and the other with the title of *A Methodology for Seismic Evaluation of Existing Multifamily Residential Buildings*. The first series of reports was condensed into *The Home Building Guide for Earthquake Design*, providing a manual on this subject for home builders.

At the present time we are supporting two additional study programs. The Earthquake Engineering Research Center of the University of California, Berkeley, is studying the effects of a Seismic Zone 2 earthquake (such as might be expected in Phoenix, Arizona, or Memphis, Tennessee), on a single story masonry house. This study, to be completed next June, includes analysis of various methods of reinforcing such a house against these loads.

The Applied Technology Council, in the second study, will take the laboratory results from the Research Center and use them to develop manuals for homebuilders and architects/engineers. The first manual, which will be similar to the *Home Building Guide* (but covering masonry instead of frame buildings), will be ready by September 1984.

In order to coordinate our work with other agencies and organizations, HUD is represented on several panels and committees concerned with seismic problems; the principal ones are:

1. U. S. - Japan Joint Panel on Wind and Seismic Effects
2. Interagency Coordinating Committee on Seismic Safety in Construction
3. Interagency Discussion Group on Disaster Mitigation.

HUD personnel are also members of or participants in several professional and code organizations which include programs addressing seismic issues; these include:

A. CABO One-and-Two-Family Dwelling Code Change Committee
B. National Institute of Building Sciences
C. American Society of Civil Engineers

Finally, we are participating in a new study being undertaken by the National Institute of Building Sciences to identify housing research needs, and this may identify other areas of seismic concern held by the Nation's housing industry.

I trust that this information will be of assistance in the Subcommittee's review of the National Earthquake Hazards Reduction Program. If we can provide further help, please call me.

Yours truly,

E. S. Savas

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

DEC 30 1982

The Honorable Doug Walgren
Chairman, Subcommittee on Science
  Research and Technology
Committee on Science and Technology
United States House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

In response to the request in your letter of December 8, 1982, the enclosed document presents a summary of the U.S. Nuclear Regulatory Commission's (NRC) ongoing research program that contributes to understanding the nation's earthquake hazards. While the NRC program in earthquake research is not an explicit part of the National Earthquake Hazards Reduction Program (NEHRP), the NRC earth science research program has broad applicability to the national earth science problems and contributes to the overall objective of the Program as outlined in the enclosure.

The NRC seismic research effort is limited to efforts in direct support of the agency's objectives but our work also contributes to understanding of the overall earthquake hazard problem. The NRC is currently concentrating its earth science research effort in the eastern two-thirds of the nation, in part because of the concentration of nuclear power plants there. There is a small scale program in the Pacific Northwest. In the past, NRC supported background work on the West Coast that was significant to then current licensing actions.

The NRC research in support of licensing actions and the development of regulatory criteria for application in regions of problematic seismicity is conducted with a high level of coordination with other agencies that are also addressing the earthquake hazard problem. This is illustrated by liaison participation of NRC staff in the annual review of research proposals for the NEHRP sent to the U.S. Geological Survey and by NRC participation in the National Academy of Sciences/National Research Council Interagency Geophysical Discussion Group.

The high level of interagency coordination and cooperation is a result of the recognition that the problem of addressing the many facets of the earthquake hazard problem (scientific, social, economic, regulatory and engineering) is a large and complex problem.

If the enclosure does not fully satisfy your Subcommittee's need for a perspective on the role that the NRC plays in the nation's earthquake hazard reduction effort, or if there is any additional information we can furnish you, please do not hesitate to contact me.

Sincerely,

William J. Dircks
Executive Director for Operations

Enclosure:
As stated

U.S. NRC Earthquake Hazard Research
vis-a-vis
The National Earthquake Hazard Reduction Program

INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) does not have specific statutory obligation under the National Earthquake Hazard Reduction Program (NEHRP) but in meeting its regulatory objectives makes a contribution to the program through the assessment of the earthquake threat to nuclear facilities. The NRC is a regulatory agency whose mission does not necessitate efforts to reduce earthquake hazards but rather the mission requires recognition of them and factoring that recognition into the regulation of nuclear safety. This briefing document is intended to show the relationship between the NRC's earthquake hazard research and the NEHRP. This is accomplished by first, outlining the goals of the NRC program; second, describing the general areas of the research; and third, indicating how the program interfaces with the NEHRP and other groups engaged in earthquake hazard research. In addition, there will be a description of the NRC program's funding history.

NRC PROGRAM OBJECTIVES

The regulatory objective of the NRC earthquake hazard research program is to reduce the uncertainty in estimating the hazard and consequent risk due to earthquakes at existing and future nuclear facilities. This reduction of uncertainty has an engineering aspect--how will the plant behave under seismic conditions--and a geoscientific aspect--what is the design basis earthquake? The following describes the geoscientific program in detail.

Establishing the appropriate design basis earthquake requires: 1) statistical data on the magnitude, frequency and location of recent and historical earthquakes, and 2) sufficient knowledge of the seismogenic mechanisms in an area to permit the extrapolation of the statistical data into the future. The NRC earthquake hazard research program is designed to develop the data and information necessary for establishing appropriate design basis earthquakes and the associated vibratory ground motions.

Because of the higher concentration of nuclear power plants in the East and also because the USGS has a very active research program on seismic hazard in the West, the NRC's program is especially directed toward the Eastern United States (east of the Rocky Mountains) where there is a particular problem in establishing the design basis earthquakes. Although there have been several earthquakes with large felt areas (such as Charleston 1886), the rate of seismicity is moderate and the historical data base is relatively short (about 200 years) and of variable quality. Also, the seismogenic mechanisms in the Eastern United States are largely unknown because of the moderate-to-low recurrence rate and the apparent lack of surface manifestation. Only in the New Madrid Seismic Zone is there a working hypothesis for the cause of the seismicity, and even in the New Madrid Seismic Zone there are still significant questions concerning the areal extent of the seismic zone. Thus, the lack of a reliable data base and the lack of sufficient understanding of seismogenic mechanisms results in considerable uncertainty in assessment of seismic hazards in the Eastern United States.

SEISMOTECTONIC PROGRAM

The NRC Seismotectonic Research Program which addresses earthquake hazards is divided into regional and topical studies (Table 1).

The regional programs are directed at specific target areas within regions of relatively moderate seismicity which have a high concentration of existing and proposed nuclear facilities. The goal for these areas is to gain specific information that will reduce the uncertainty in determining the extent of seismic source zones, the magnitude of earthquakes associated with them, and the recurrence rates of earthquakes in the regions. The programs include seismic monitoring, specifically directed geologic studies, and geophysical investigations.

The regional study areas are identified as the Southeast, the Northeast and the New Madrid and Nemaha regions. The source of the uncertainty is different in the different areas. Consequently, the type of investigations in and the delineation of the areas also vary. As the programs progress, our perception of the factors most affecting the uncertainties may change; consequently, it will be necessary to constantly re-evaluate the programs and to changes in direction as required.

In general, the regional programs are directed at determining the cause of seismicity through continued monitoring by use of seismographic networks; examination of recent crustal strain; active in situ tectonic stress; geophysical investigations of the structure of the crustal hypocentral depths; and detailed geologic mapping in specific problem areas. Determining the cause of the seismicity is the general objective because the lack of knowledge of the cause of eastern seismicity is a major factor in the uncertainty of estimation of location and size of earthquakes in the Eastern U.S. To a certain extent the cause of seismicity in the New Madrid area is established and consequently the direction of that program has been redirected to reflect this new information.

The topical program category is directed at sources of uncertainty that are not related specifically to given seismic source zones. These programs include ground motion studies (near-field strong motion and site specific spectra) and attenuation relationships on regional bases. These topical seismic programs complement the regional programs in that they are primarily directed toward the uncertainties in establishing vibratory ground motion at a site caused by a given magnitude earthquake at a known location.

There are some proposed programs that bridge the Regional and Topical categories, such as examination of the hazard consequence of alternative models of the cause of earthquakes coupled with alternative ground motion models.

NRC Interface with NEHRP

A first significant step in any earthquake hazard reduction program is the identification and assessment of the earthquake source zone and the hazards associated with them, i.e., what and where are they and how great is their threat. This objective is also relevant to the NRC regulatory role of ensuring that licensed facilities are designed to provide adequate protection against the regional earthquake hazards. Thus, while the NRC does not have a specific role in the NEHRP, its research program does contribute to the national effort.

A principal mechanism for the NRC contribution to the NEHRP is through the funding of hazard identification and assessment research and the rapid dissemination of the research results. The identification of earthquake hazard is conducted mainly through the regional program while the assessments are made a part of both the regional and topical programs.

In the identification phase, the NRC contributes a significant share of the support for fifteen seismographic networks in the Eastern United States including support for the U.S. Geological Survey network in the Charleston, S.C. area. This program also includes geophysical surveys, in-situ stress measurements, and significant investigations of geological structures that may be active or indicators of activity. In the assessment phase, the NRC regional research contributes to evaluation of the maximum magnitude earthquake that can occur within a region while the topical program assesses methodologies for calculating the recurrence interval between large earthquakes.

The NRC requires a camera-ready copy of final reports and important results so that they may be published in its NUREG series, in part to foster the rapid dissemination of research results. The NRC also encourages the publication of results in open refereed journals.

The NRC does not submit its earth sciences program to other federal agencies for approval but does provide copies of the research program for comment. NRC staff members sit on many interagency panels as either full panel members or as liaison members to foster the coordination and cooperation of the various university, state, and federal research groups. Among the more significant panels are the National Academy of Sciences' Geological Sciences Board and its Committee on Seismology; the U.S. Geological Survey's Office of Earthquake Studies Advisory Panel and its Proposal Review Panel; the National Science Foundation's Proposal Review Panel; and the National Research Council sponsored Interagency Geophysical Discussion

Group including U.S. NRC, U.S. Geological Survey, National Science Foundation, Department of Energy, National Oceanic and Atmospheric Agency, Department of Defense, National Aeronautics and Space Administration, and the National Academy of Sciences.

More than half of the NRC research funding goes into projects which are cooperative efforts with the participating organizations sharing the scientific results and the costs. (A partial list of cost-sharing partners is shown in Table 2.) The cost-sharing of projects is an efficient and effective way to finance research and to ensure rapid dissemination of research results.

Fund History

The level of funding for NRC Earth Sciences Branch research (or its predecessor branches) is shown in Table 3.

Table 1

EARTH SCIENCES BRANCH - RESEARCH

	FY 83
GEOLOGY AND SEISMOLOGY	4505
REGIONAL STUDIES	3303
Southeastern U.S. (including Charleston)	1360
Northeastern U.S.	928
New Madrid Region (plus Anna Ohio)	565
Nemaha Ridge	120
Pacific Northwest	30
Improvement of Instrumentation + Analysis	200
TOPICAL STUDIES	1202
Site Specific Spectra	60
Generic Studies	462
Strong-Motion Seismograph	50
USGS Topical Studies	430
Geo. Tech. Eng.	30
In-Situ Stress Measurement	170

Table 2

Cost-Sharing - Seismology

Contractor	Annual NRC-Cost	Annual Funding	Recent one-shot funding
Northeastern Networks			
Boston College	$ 190K	$ 10K (COE)	
M.I.T.	90K	50K	
Columbia University	220K	100K (USGS) 10K (NYGS)	$ 82K (USGS)
S.U.N.Y. at Stony Brook	30K		
Canadian Commercial Corp.	130K	150K	
Others		165K (Con Ed) 350K (Eserco)	
Approx. Totals	$ 660K	$ 825K	$ 82K
Southeastern Networks			
Virginia Polytechnic Institute	110K	70K	70K
Alabama Geological Survey	55K		
Tennessee Earthquake Information Center	175K	110K	67K (Tenn)
USGS (Charleston, S.C. Network & related studies)	600K	600K	
Approx. Totals	$ 930K	$ 780K	$137K
Central U.S. Networks			
St. Louis University	$ 145K	$ 132K (USGS)	
Michigan University	100K		
Approx. Totals	$ 245K	$ 132K	

Cost-Sharing - Geology

	NRC	Contract	
New England			
Boston College	$ 320K	$ 113K	- Cost shared by sub-contractors States of: Delaware New York Conn. Rhode Island Maine
New Madrid			
Kentucky G.S.	30.	10.0	
Indiana G.S.	30.6	9.4	
Illinois G.S.	34.8	10.0	
Miss. G.S.	38.5	3.8	
Alabama G.S.	30.0	9.0	
Missouri G.S.	39.0	3.0	
St. Louis Univ.	0	19.0	
Vanderbilt	15.	16.2	
Purdue	110.0	23.4	
	429.7K	103.8K	

This table was compiled on an informal basis and thus subject to corrections.

Table 3

Funding Levels of NRC Earth Science Research

FY75	$1,085K	
76	2,855K	
77	3,245K	
78	3,125K	
79	3,500K	
80	3,600K	
81	3,745K	
82	3,400K	
83	4,500K	Projection
84	5,100K	Projection

APPENDIX II—Letter—Center for Building Technology, National Bureau of Standards

CONSULTING ENGINEERS
MERRITT CASES INC.
CIVIL, STRUCTURAL, & GEOTECHNICAL

15 March 1983

The Honorable Doug Walgren
Committee on Science and Technology
ATTN: Ms. Carrye Brown
Room 2321
Rayburn House Office Building
Washington, D.C. 20515

Re: Funds for "Learning from Disasters"

Dear Congressman Walgren:

As a representative of a Private Sector organization, I should like to share my views with you as you address questions on research on hazards and disasters. Among other assignments, CASES, since its inception, has been involved in research on engineering effects of natural and man-made disasters. Currently in the field of earthquake engineering, we are pursuing a program of experimental research on behavior of buried lifelines which is sponsored jointly by the Defense Nuclear Agency and by the National Science Foundation, and separately a program to evaluate the seismic risk for selected, mission-critical facilities at Naval Air Facility, El Centro.

Although philosophically I agree that the Private Sector must assume its rightful share of cost, the magnitude of potential loss in a major disaster, measured in economic terms or in human suffering and loss of life, makes the available share from the Private Sector woefully inadequate. I maintain the latter is true whether the Private Sector is considered individually or collectively: Profit margins and/or IR&D budgets, even in the best of times, are such that individual firms cannot afford the very substantial contributions of money, manpower or services required to "learn from the often unique and pervasive conditions produced by occurrence of disasters." Collectively the various professional societies, a natural "vehicle" for joint action, are finding it more and more necessary to curtail essential activities, let alone find funds to do research on effects of disasters.

Historically, especially in the fields of earthquake engineering, wind damage, flooding and accidental collapse, funds have been available through DoD, DOT, NBS, NSF, USGS and related Federal and State organizations to assure that the unique conditions produced in these disasters have a much reduced probability of causing major damage in future recurrences of the phenomena. An excellent example of cooperation among the organizations mentioned above and countless, selfless individuals is the effort mounted to document the 1964 ("Good Friday") Alaskan Earthquake.

I perceive this country is potentially going to lose the unique opportunity to learn from disasters -- and simultaneously the ability to reduce the potential tremendous loss from disasters -- if funds are not made available to public organizations who normally support efforts to learn from natural disasters. True, funds were made available in the Earthquake Hazards Mitigation Act of

P.O. BOX 1206 • REDLANDS, CA 92373 (714) 793-2027 OR 824-8522 • FACSIMILE: 793-2028 • TELEX: 183511-CSMA

1977, as amended, but the impact of these funds is waning since budgets have not nearly kept up with inflation in the late 1970's and 1980 and 1981; furthermore, it seems to have proved impractical to include "no-year" funding which can realistically be carried forward to the time when a disaster provides the unique opportunity to avoid repetition of the severity of the damage.

In summary, I believe that funds which might be available from the Private Sector to "learn from natural and man-made disasters" will remain woefully inadequate to reduce the probability of significant economic and human loss; funds available from the Public Sector are about to "dry-up" due to "management decisions" of insisting either that the Private Sector must carry the total burden or that agencies must spend all of their frequently shrinking appropriations or lose them -- actually or effectively by suffering reductions in later appropriations. Not learning from the often unique conditions accompanying every major disaster is a potential disaster in its own right.

Very truly yours,

Merritt CASES, Inc.

J. L. Merritt

J.L. Merritt, P.E., Ph.D.
President/Treasurer

JLM:pjj

XC: Cong. George E. Brown, Jr.
Sen. Alan Cranston
Sen. Slade Gorton
Cong. Jerry Lewis
Sen. Pete Wilson

DR. DOROTHY M. SIMON
VICE PRESIDENT, RESEARCH

FEB 21 1983

February 16, 1983

The Honorable Doug Walgren
Chairman, Subcommittee on Science,
Research and Technology
Committee on Science and Technology
Room 2319
Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

As Chairman of the Statutory Visiting Committee for the National Bureau of Standards, I am taking this opportunity to present the Committee's views on NBS. Besides myself, the Visiting Committee has four members: Dr. Russell G. Meyerand, Jr., Vice President for Research and Development at United Technologies; Dr. Bernard M. Oliver, Vice President (Retired) of Hewlett Packard Company; Dr. Walter H. Stockmayer, Professor of Chemistry at Dartmouth College; and Dr. Norman F. Ramsey, Higgins Professor of Physics at Harvard University. As you know, the Committee meets twice a year at the Bureau and reports annually to the Secretary of Commerce on its technical activities. In doing so, the Committee benefits greatly from the reports of the evaluation panels chaired by Dr. Mildred S. Dresselhaus (Director, Center for Materials Science and Engineering, Massachusetts Institute of Technology). These panels examine the work of the National Measurement and Engineering Laboratories and the Institute for Computer Sciences and Technology and make recommendations to the NBS management.

The Visiting Committee appreciates the commitment that the Reagan Administration has made to reducing the growth in Federal spending and the severe constraints that that commitment has placed on the budget. We have kept this in mind during our review of NBS activities and in our attempt to identify problems that might reasonably be dealt with in this context.

The last meeting of the Visiting Committee was held on Wednesday, February 2, 1983. At that time the Director of the Bureau of Standards, Dr. Ernest Ambler, reviewed the proposed changes in the 1984 budget with us. The FY 1984 budget provides 25 million dollars or 20% less than the

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base budget of FY 1983. Four hundred and seventy-five positions are in jeopardy - 179 are directly tied to programs being eliminated and an additional 296 are vulnerable to overhead reductions and other agency funding.

This severe blow comes at a time when the NBS staff is already lean and just recovering from the disruption of earlier reductions. Over the past two years, the Bureau has reduced its force by 534 people or approximately 15 percent of its staff. The reduction was managed exceptionally well; morale is good, and new initiatives continue to be undertaken through reprogramming. However, cuts of this magnitude have serious long-term consequences. Because the more senior employees have bumping privileges, the Bureau has effectively lost a whole generation of bright young scientists and technicians. A reduction of a further 15 percent at this time would precipitate a major reorganization in the Bureau's management structure and in the use of its facilities. There is no way that this could happen without seriously jeopardizing the ability of NBS to fulfill its mission.

This drastic decrease in the NBS budget is all the more alarming in view of the Administration's proposal to increase the funding of Research and Development (R&D) by 18 percent throughout the government. Thus in a year when the Administration is requesting an increase of 29 percent in R&D for the Department of Defense, 32 percent for the Department of Transportation, and 17 percent for the National Science Foundation, the Department of Commerce is actually requesting a decrease of 28 percent in its R&D budget. The only other agencies or departments requesting substantial reductions in their R&D budgets are the Environmental Protection Agency with a 14 percent decrease and the Department of Interior with 12 percent. Even in the light of the Administration's funding policies, the Department of Commerce seems to be way out of line in its support of R&D.

Of the seven areas in which the Bureau is proposing to make major reductions, I have chosen to comment here on two: fire and building research. The Administration argues that these decreases are largely in short term applied research and development, more appropriately the responsibility of the private sector. Let us examine the possibilities for the private sector to undertake the effort in each of the two areas.

The NBS fire program is the only Federal effort aimed at the reduction of annual fire losses of 8,000 lives, 200,000 injuries, and $20 billion in costs. Fires in residences, such as homes, hotels, and care facilities, account for 77 percent of these deaths, 68 percent of the injuries and 46 percent of the dollar losses. The NBS program is the only technical effort in this country directed towards the problem of residential fires. Its results are used by designers, manufacturers, builders, standards writing committees, and State and local code officials.

Except in special cases, the private sector has no incentive to conduct research into fire safety. Fire insurance underwriters deal with the protection of property; since they generally set premiums on an actuarial basis, their profit does not depend on reducing losses. The NBS program is aimed at the protection of life.

In those special cases where the private sector does conduct efforts to reduce fire losses, their activities are usually mission oriented and narrow in scope. As such, they do not overlap with those of the Bureau. NBS does not, for example, engage in technology or development of commercially marketable materials. Nor does NBS do routine tests; product certification is handled by Underwriters Laboratories, Inc. The Factory Mutual Research Corporation, the largest non-government fire laboratory in the country, does indeed address fire protection of industrial buildings and their contents, but industrial fire protection systems are not suitable for residences. Thus NBS conducts the only comprehensive fire research program in the country. Its program is designed to provide the scientific basis for the prevention and control of all types of fires.

A decade ago, NBS scientists provided basic information on the characteristics and movement of smoke. This information was incorporated into the test procedures used in certifying smoke detectors, which now save 1,000 lives annually. More recently, NBS scientists identified cigarettes as the single largest source of fatal fires. Their work in developing test methods for determining the resistance of mattresses and upholstered furniture to cigarette ignition has the potential of reducing fire fatalities by 20 percent.

In addition to the work carried out on site, NBS is the principal source of support for fundamental fire research throughout the United States, providing annual funding of $1.75 million to about 30 universities. This is consistent with the Administration's policy to derive educational and training advantages from federally-supported research. In maintaining these contracts, the Center for Fire Research provides the link between university research and the needs of fire technology.

Improvements in the cost-effectiveness of fire protection systems can have significant economic returns. The construction of new buildings and the rehabilitation of existing buildings runs about $230 billion annually; $7.6 billion is spent on fire safety. Forty percent of this expenditure could be saved by making more informed decisions on the trade-offs between safety, cost and function. The NBS Fire Safety Evaluation System allows designers to make just such decisions in meeting the requirements of the Life Safety Code. In rehabilitating one hospital, use of NBS guidelines saved $4 million out of an $11 million project; in another hospital, it saved $2 million out of $5 million.

The beneficiaries of the NBS fire research program are the general public. To eliminate this program would be to neglect the Nation's severe fire problem.

The issues associated with the elimination of the Bureau's program in building research are different but equally complex. Construction is one of the Nation's largest industries. In 1981 it amounted to $234 billion or eight percent of the gross national product. Sixty-nine percent of the Nation's wealth is invested in constructed facilities that shelter and support almost all human activities. NBS is the only comprehensive, non-proprietary laboratory dedicated to meeting the measurement requirements of the building community. Its program includes substantial efforts in structural engineering, building materials, building equipment and systems. Authorized by the NBS Organic Act of 1901, the Center for Building Research has led the national effort in building research for 80 years.

There are other organizations that could be considered to conduct the building research associated with the budget reductions at NBS. But each of these has its own particular skills, facilities and enthusiasms. No one of them could readily be expanded into an integrated program capable of dealing with the complex technical issues that affect the entire building industry. The Department of Defense, for example, focuses its research programs on problems related to military applications. Many problems of interest to the building community are not included. Several defense laboratories have sponsored research at the Center for Building Technology in order to take advantage of the technical expertise and unique experimental facilities not available elsewhere.

The larger manufacturers of building materials and equipment also conduct research related to building technology. But here the effort focuses on the development of new products. Most of the work is proprietary and does not address the diverse technical problems of the building community. These laboratories could not perform the generic research oriented towards performance that is conducted by NBS.

NBS is the only neutral laboratory capable of investigating the physical causes of major structural failures. It reported on the collapse of the walkway in Kansas City that killed 114 people in 1981, the failure of the overpass in East Chicago that killed 13 construction workers in 1982, and the collapse of the cooling tower at Willow Island that killed 51 construction workers in 1978. Such reports assure that the causes of the disasters are publicly known and can be avoided in the future.

NBS is the major source of non-proprietary information for use by building code officials for revision codes and for determining compliance. This program makes major contributions toward reducing the burden of unnecessary building regulations while maintaining essential levels of safety. For example, NBS, in cooperation with the National Conference of States on

Building Codes and Standards, developed a more cost-effective approach to regulating the rehabilitation of buildings. This approach has been adopted by the State of Massachusetts and incorporated in rehabilitation guidelines of the Department of Housing and Urban Development. In still another example, NBS formulated an approach for design standards for energy conservation in buildings. This has been adopted as a national standard by the American Society for Heating, Refrigerating and Air-Conditioning Engineers. It provides the basis for the energy building code of 44 States.

The construction industry is one of the three major disaggregated industries in the country. The other two are health services and food. From a statistical abstract published by the Department of Commerce in 1981, it appears that the health service industry received $4 billion in Federal research support, and the food industry $890 million. The comparable figure for the construction industry is $22 million, all of it at NBS. With over 4 million construction workers and over one million construction firms, the industry simply could not organize itself to conduct this research without Federal support.

I have attempted in this letter to convey to you the seriousness with which the NBS Visiting Committee regards the proposed elimination of the Centers for Fire Research and Building Technology. Every major country in the world has found it necessary to maintain a fire research laboratory in its central government; every developed country in the world has a building research laboratory. I hope the Committee on Science and Technology will give its full support to these two national assets.

Sincerely,

Dorothy M. Simon

Dorothy M. Simon
Vice President, Research
Avco Corporation
Chairman, National Bureau
of Standards Statutory
Visiting Committee

DMS:vh

CF.
JH

THE
AMERICAN
INSTITUTE
OF
ARCHITECTS

Robert Broshar, FAIA
President

1735 New York Avenue, N.W.
Washington, D.C. 20006
Telephone: (202) 626-7300
Cable Address: AMINARCH
Telex: 710822 1112

March 30, 1983

The Honorable Don Fuqua
U.S. House of Representatives
Washington, D.C. 20515

Dear Congressman Fuqua:

As President of the American Institute of Architects, I want to submit the AIA's statement on the FY 1984 budget for the National Bureau of Standards' Center for Building Technology and Center for Fire Research.

In 1981 our government spent $22 million on very valuable building research at NBS. This amount was less per capita than any other developed nation and was less than amounts spent for most other U.S. industrially related research. For FY 84 the administration is recommending that all of this federally supported research be terminated. This action, if approved could make the United States the only developed nation in the world without a national research program for building technology and fire prevention. The AIA strongly opposes the Reagan Administration's proposal for zero funding for the CBT and CFR. We join others in the business community to call for Congress to fund these programs in FY 84 at no less than that approved in FY 83. Congressional hearings have demonstrated the importance of an expanded role for NBS in the exact areas the President has proposed eliminating.

With 80% of our lives spent indoors and 70% of our wealth invested in the built environment, we can not afford to reduce our commitment to improving safety in the built environment. NBS is the only one capably of performing the non proprietary technical research necessary to improve this nations life safety record, which is presently one of the worst in the world. We believe a small investment in research today will result in major savings from the prevention of future loss of life and property.

I encourage your comments and questions on our enclosed statement. Contact my office if the AIA can be of assistance to you in this or other issue areas.

Sincerely,

Robert Broshar

Robert Broshar, FAIA
President

Enclosure

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

APR 4 [illegible]

THE
AMERICAN
INSTITUTE
OF
ARCHITECTS

1735 New York Avenue, N.W.
Washington, D.C. 20006
Telephone: (202) 626-7300
Cable Address: AMINARCH
Telex: 710822 1112

THE FY 1984 BUDGET FOR THE NATIONAL BUREAU OF STANDARDS' CENTER FOR BUILDING TECHNOLOGY and CENTER FOR FIRE RESEARCH

A Statement by
THE AMERICAN INSTITUTE OF ARCHITECTS

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
SCIENCE, TECHNOLOGY AND SPACE SUBCOMMITTEE
U.S. SENATE

The American Institute of Architects opposes the proposed elimination of funding for the Center for Building Technology and the Center for Fire Research. In our opinion, the design community and the public have benefited from the research programs carried out at the National Bureau of Standards (NBS). They have made important contributions in the areas of seismic safety, energy conservation and fire safety research.

The AIA cannot accept the administration's assertion that the private sector or local and state governments can provide the non-proprietary technical research needed in these areas. No one element in the building sector would find it to its economic advantage to carry out the activities that NBS has been responsible for. Additionally, NBS is in a position to provide impartial information, a function that would be lost if NBS's programs were to be eliminated.

The structure of the building industry prevents it from picking up the type of research that NBS carries out. The building industry, which in 1981 accounted for $234 billion or 8 percent of the gross national product, is a highly fragmented industry. Of the 1.2 million firms which employ 4.3 million workers, approximately 60 percent are small businesses. For example, 80 percent of the architecture firms in this nation have fewer than 10 employees. Engineering firms are only slightly larger. Because of this fragmentation, the research capacity of the design community is very limited. The research carried out by architectural and engineering firms is of an applied nature and is limited to the information needed for specific design and construction projects. And the research components of the building indus-try's trade and professional associations are unable to pick up the type of research that has been carried out by NBS.

In an industry such as ours, which is mainly made up of small businesses, we cannot assume that market forces, such as litigation costs from building failures, will spur private sector research. For example, architectural and engineering firms are already suffering from severe liability problems, due to incremental changes in tort law. In 1981, the claim rate for A/E firms was 45 per 100 insured firms. The average cost of these claims was $64,000. Yet, because of the fragmented nature of these experiences, this substantial increase in the cost of doing business has not brought about an increase in the amount of private sector research on structural failures. While groups like the University of Maryland's Architecture and Engineering Performance Information Center can analyze and disseminate information on structural failures, they cannot directly perform the research. Nor can any single architectural firm or consortium of architectural and engineering firms perform this type of research.

In August of 1982, the AIA testified before Congress on structural failures in public facilities, where we outlined the need for more data for the systematic analysis of the nation's building failures. At that time, the Institute applauded the Center for Building Technology's independent investigation of structural failures, such as the Kansas City Hyatt collapse. The NBS investigation provided insights into the causes of that collapse that would have otherwise gone undocumented. These investigations provide valuable information which will help prevent past mistakes from being repeated. However, we must stress that investigations on building failures are costly. For example, NBS's investigation of the Hyatt Hotel collapse cost about a half a million dollars. In most cases, the cost of these investigations on complex structures ranges between $100,000 and $500,000. Each year NBS carries out one or two in-depth investigations as well as several minor ones. We think this investigatory capacity should be expanded.

Recent structural failures and fire disasters have brought forth a public outcry for safer buildings. Research to further this goal should be carried forward with enthusiasm worthy of the public trust. Research on these subjects protects the health and welfare of the nation's citizens, a well-established federal responsibility.

By eliminating funding for these programs, the Administration seems to be saying that this long-held federal responsibility should be left to private sector organizations.

In conclusion, The American Institute of Architects has always supported programs which seek to protect the health, safety and welfare of the public. In recent years, for example, the Institute convened a Long-Span Building Panel and a Life Safety Task Force to study issues of safety in public buildings, but these limited-scope studies cannot replace the non-proprietary technical research being performed by NBS. The AIA can disseminate information generated by federal efforts to the architectural profession, as we have done in the energy area, but we cannot undertake the basic research in these areas.

Continued funding for the Center for Building Technology and the Center for Fire Research is essential to the continuation of these important areas of investigation. We believe that these programs should be funded at least in the amounts appropriated for FY 1983. NBS plays a unique role in supporting much-needed research for a highly fragmented industry. We believe the small investment in research today will result in major savings in the prevention of future loss of life and property.

National Association of Home Builders
15th and M Streets, N.W., Washington, D.C. 20005
Telex 89-2600 (202) 822-0400

Harry Pryde
1983 President

April 7, 1983

The Honorable Doug Walgren, Chairman
Subcommittee on Science, Research and
Technology
Committee on Science and Technology
2319 Rayburn House Office Buiding
Washington, D.C. 20515

Dear Chairman Walgren:

On behalf of the more than 105,000 members of the National Association of Home Builders (NAHB), of which I am President, I urge you to support reauthorization of the National Bureau of Standards' Center for Building Technology (CBT) and the Center for Fire Research (CFR). Both of these research centers have provided and continue to provide necessary construction related research which simply cannot be duplicated by the private sector.

Through the efforts of the Center for Building Technology on the FTC Insulation labeling regulation, approximately $90 million per year in potential compliance costs was averted as a result of the development of the guarded hot plate by CBT. These compliance costs would have been passed on to consumers in higher appliance costs. The Center for Building Technology also completed a comprehensive investigation of the 1981 hotel walkway collapse in Kansas City, which resulted in improved design and construction procedures.

Likewise, the Center for Fire Research has been in the forefront in the development of testing equipment to quantify characteristics of materials which have been subject to fire. The CFR's efforts aimed at fire protection methods have also proved invaluable, such as the program developed for high-rise buildings as a result of the MGM Grand Hotel fire in Las Vegas.

I urge you to continue support of both centers and funding of their programs which produce a substantial return to the taxpayer for their investment. NAHB also supports and urges the Congress to consider the establishment of an industry advisory board to assist both centers in selection of research subjects and projects;

to provide advice on research methodology, and to assure that research results are useful and may be applied to reducing the cost of improving the value of housing and buildings.

I would also like to express NAHB's support for the National Voluntary Laboratory Accreditation Program (NVLAP). This program plays an essential role in the practical application of improved product standards. NVLAP is a link between the research products of the Center for Building Technology and the Center for Fire Research and the building community.

I thank you for this opportunity to express our views on these important programs.

Sincerely,

Harry Pryde

Harry Pryde
President

American Iron and Steel Institute

1000 16th Street, N.W., Washington, D.C. 20036

William H. Hoffman, Jr.
Vice President
Government Relations
(202) 452-7230

March 21, 1983

The Honorable Doug Walgren
Chairman
Subcommittee on Science, Research, and Technology
Committee on Science and Technology
U. S. House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

The budget for the National Bureau of Standards submitted by the Administration calls for the elimination of the Center for Fire Research and the Center for Building Technology.

I am writing on behalf of the American Iron and Steel Institute to urge that you support the restoration of these funds to the NBS as you begin hearings on its FY 1984 budget.

(Senator Gorton has introduced a bill, S. 821, which would restore these funds, among others, to NBS, and we have written him in support of his effort. He would restore $5.886 million to the Center for Fire Research and not less than $4.009 million for "Building Research.")

The research resources required to effectively deal with the reported annual fire waste in the United States, which involves 8,000 deaths and $20 billion in direct and indirect property loss, is beyond the financial and technical resources of any one industry or industry group. The fire research effort requires the talent of many different scientific and engineering disciplines doing the pieces of research which are then fitted into the total fire safety puzzle. The Center for Fire Research has the staff and facilities to efficiently and effectively concentrate on the fire safety problem as it affects the public. No industry or existing private testing facilities can approach the research capabilities of the Center for Fire Research.

Currently industry is participating directly in research at CFR through the Research Associate Program. AISI is only one of many industry groups that have financially contributed to fire research studies at CFR. Several of these studies are explained in attachments to this letter.

The unique aspects of the fire problem necessitates the development of new test methods and time-consuming experimental evaluation required of test methods before recognition and acceptance by the technical community. These test methods are adopted by consensus action of the various voluntary code and standards writing organizations. In turn, the tests are adopted as part of the performance criteria in building regulations which are designed to protect the general public from injury and personal property loss resulting from fire. Because of the end use of fire test methods in building codes, the Center for Fire Research is especially suited to develop such tests and conduct the basic research. It is essential that the current broad base funding for this CFR activity be continued.

The Center for Building Technology has undertaken a wide range of activities which have resulted in improvements in construction technology and the knowledge of structural and building performance resulting in design techniques to make buildings safer from the effects of natural hazards such as earthquake and wind storms. The CBT program has made major contributions in relieving the burden of unnecessary regulations on construction while maintaining essential levels of safety. Some of the significant studies and activities of the CBT are explained in attachments to this letter.

The Center for Building Technology and Center for Fire Research have proven records of accomplishments and offer unique facilities and perspectives that cannot be replicated by the private sector.

We, therefore, urge you and your colleagues to restore the funds as specified in S. 821 to enable them to continue their invaluable services to the Nation.

Sincerely,

Bill Hoffman

Enclosure

A. CFR FIRE RESEARCH ON TOXICITY OF BURNING COMBUSTIBLES

Fire experience in the United States indicates that approximately 75 percent of fire deaths in building fires are caused by the toxic effects of the products of combustion from burning building materials and furnishings. In a recent report published by the National Fire Protection Association from a study by the Committee on the Toxicity of the Products of Combustion, seven primary areas were noted as requiring additional study. Three of these are related to research currently under way at the Center for Fire Research and are as follows:

1) Standardized and improved methods of autopsy examinations and medical evaluations should be an integral of fire investigations; Improved quality control of biochemical measurements made on fire casualities,
2) Long term medical assessment of fire fighters and survivors of fires, especially for residual respiratory and cardiovascular changes, and
3) Studies of the composition of combustion and pyrolysis products in the fire environment must be integrated with toxicological and medical evidence of the physiological effects in animals and fire casualties

Recognition was given to the CFR biological toxicity test, but it was indicated that certain conditions should be studied to make the NBS test protocol more effective. The recommendations for further research are as follows:

1) A uniform distribution of heat and smoke throughout the animal exposure chamber.
2) Samples tested under conditions representative of their end use configuration.
3) A method for determining a meaningful exposure time, especially for testing materials that decompose at different rates.
4) Chemical measurements of the principle components of the combustion products.
5) A method of monitoring and correcting for concentration changes due to absorption of combustion product mixture to which the animals are exposed.
6) Sample weight loss versus time measurement (thermogravimetric monitoring).
7) Measurement of toxicity in exposed animals short of death such as time to incapacitation and persistent effects in surviving animals.

The scope of any project involving toxicity of combustion products requires the interface of many different specialized disciplines and unique test facilities which can be productive in developing necessary test procedures. AISI has proposed a cooperative research program at the Center for Fire Research making use of the CFR laboratory fire research facilities and technical staff to study the following:

1) Develop a toxic hazard assessment as part of any fire hazard assessment for life safety in fires.
2) Combine the existing room fire growth models developed by AISI and CFR.
3) Combine the research on standardizing a test method for determining the toxicity of combustion products with the AISI sponsored project for on the scene determination of death of fire victims which is to be studied in three cities in the United States with cooperation from the local fire department and the medical examiners office.

The proposed AISI budget for this work which is to compliment the work done at the Center for Fire Research is presently estimated at $185,000.

The proposed elimination of the CFR budget will virtually stop all work by industry on this subject.

B. CFR FIRE RESEARCH AND STRUCTURAL FIRE ENDURANCE PROGRAM

AISI has contributed significant research dollars at the Center for Fire Research in a joint research program developing reliable methods for evaluating fire endurance of structural building systems. The work done to date by AISI has been evaluated through the use of a complicated test program which can only be done at the Center for Fire Research.

Through the efforts and financial contributions by AISI, a large scale, two-story test building was erected and CFR instrumented the structure so as to measure the reaction of the test structure when exposed to fire. The research program completed at the Center for Fire Research was fundamental to the successful completion of a long term effort by AISI, the Institute for the Ironworking Industry and other related industries, aimed at improving life and property safety from fire. Eliminating the Center for Fire Research will effectively destroy the capability of the efforts of the private sector to find solutions to the building fire problem.

C. CFR FIRE RESEARCH ON HVAC SYSTEMS

AISI fire research conducted at CFR has provided important technical data for modifying building codes and fire safety standards on heating, ventilating and air conditioning systems including ductwork.

Following a serious fire in New York City, fire research sponsored by AISI was conducted at CFR to evaluate the influence of the HVAC system in that building fire in spreading fire to several additional floors. The NBS research found that specific conditions must be met when ductwork penetrates fire rated floors if fire spread is to be prevented. The results of this fire research were made an integral part of fire protection standards for the safe installation of air conditioning systems.

The spread of smoke in building fires was most obvious in the MGM Hotel fire in Las Vegas, Nevada. One of the factors in the spread of smoke and hot gases from the casino fire at ground level was the air handling system. Most of the fire deaths in the MGM Hotel fire were twenty floors or more above the uncontrolled fire in the casino. Studies in smoke control during building fires include the use of the existing HVAC system, because of the elevated temperature conditions, has been questioned by many authorities. Proposed research at CFR by AISI will study the performance of currently specified HVAC ductwork under fire conditions to determine the safety and effectiveness of duct system designs presently proposed by regulations for smoke control systems.

Test equipment, instrumentation, technicians and recording equipment available at the Center for Fire Research will be lost to industry seeking to study this problem if the CFR is eliminated from the Department of Commerce budget.

D. CBT INVESTIGATION OF MAJOR BUILDING AND CONSTRUCTION DISASTERS

The most dramatic success that CBT has had recently is the definitive study on the collapse of two suspended walkways at the Hyatt Regency Hotel in Kansas City, Missouri. CBT had the technical staff to make such a study. They had the unquestioned support of the local community and they had access to the site that private organizations would not have had except with tight restrictions imposed by various financially interested parties. Never before had the construction industry learned the facts of a disaster so soon after the tragedy. There has been, for many years, routine thorough investigations of commercial airline accidents.

E. CBT EARTHQUAKE HAZARDS MITIGATION

One of the major hazards facing a great many Americans is an earthquake. Although there has been dramatic improvements (in some places) in building design and construction since the 1933 Long Beach, California, earthquake, which initiated real concern for seismic design, much is yet unknown. And what is known is not routinely applied in locations where seismic resistant construction will be seismicly tested one day. CBT is now involved in a project which they title "Technical Assessment of Earthquake-Resistant Design Provision." This effort has real value for the federal government which is the owner of a large number of buildings in active earthquake zones. It is also extremely practical for the whole construction industry. The latest improvements in seismic design provisions, drafted as a result of recent failures, have not yet been practically tested. The analytical research that is being done by CBT in conjunction with the Building Seismic Safety Council, a private organization with limited funds, will eventually save many lives.

CFB

**National Forest
Products Association**

Forest Industries Building • 1619 Massachusetts Avenue, N.W.
Washington, D.C. 20036 • 202/797-5810

Ralph D. Hodges, Jr.
Executive Vice President

JH

February 22, 1983

FEB

The Honorable Douglas Walgren
Chairman, Subcommittee on Science,
Research and Technology of the
Committee on Science and
Technology
Cannon House Office Building 117
Washington, D.C. 20515

Dear Mr. Walgren:

Reference is made to forthcoming hearings on the role and future funding of National Bureau of Standards (NBS) programs in the fields of building technology and fire research.

The National Forest Products Association is a federation of lumber and wood products associations and producing companies throughout the United States. Among the services performed for this membership, we have had a history of extensive involvement in building codes, construction standards and regulations relating to structural design and fire performance of buildings.

For the past 10 years we have financially sponsored a fire-research associate at the NBS Center for Fire Research. We are also familiar with fire testing performed by the Center and its activities in development of fire performance standards.

We have monitored energy performance testing of the Center for Building Technology (CBT) and have a close familiarity with the "Operation Breakthrough" housing standards effort of the CBT with HUD a number of years ago.

As a result of this and other experience, we believe the NBS Center for Building Technology and the Center for Fire Research serve a useful purpose in development of basic data on wind, snow, seismic forces, and fire technology involved in design of buildings. We have been concerned, however, with a perceived tendency of NBS personnel to attempt to establish performance limits on materials and constructions and to utilize the prestige of NBS in advocating acceptance of proposed standards and in seeking enactment of building code requirements before consensus is achieved on pending standards.

In short, we support limited NBS building technology and fire research activities primarily in the basic data development fields. We ask that a mechanism for industry guidance to such developmental effort be established. And, we urge that the National Institute of Building Sciences, as authorized under Public Law 93-383, be assigned responsibility for analyzing the role of NBS involvement in building and fire technology and recommending specific areas of research need.

Sincerely,

Ralph D Hodges Jr

Ralph D. Hodges, Jr.

SMACNA

MAR 29 1983

March 28, 1983

Honorable Doug Walgren
Chairman, Subcommittee on Science,
Research and Technology
2319 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

During their recent visit with you, SMACNA contractors from Western Pennsylvania described their concerns about the proposed termination of the Centers for Building Technology and Fire Research in the National Bureau of Standards. Kenneth Enscoe, SMACNA Chapter Executive in Pittsburgh, conveyed to us your request for additional information on how terminating these Centers would affect SMACNA contractors and the public interest.

Both Centers work in areas of vital concern to the entire construction industry. For example, it is generally conceded that most fire fatalities occur because of smoke and other combustion products. Only now are we beginning to learn enough about the movement of smoke and other toxic combustion products in burning structures that we can design into air conditioning systems the capability of smoke control. If the Center for Fire Research is terminated, further advances in smoke control will be halting and erratic for there will be no single entity to lead and to coordinate research, or to conduct expert, unbiased investigations into the causes and effects of fires.

Over the years, the Center for Building Technology has conducted many programs of vital interest and concern to the air conditioning industry. When the Congress enacted a law requiring manufacturers to disclose to consumers the seasonal operating costs of furnaces, air conditioners, heat pumps and similar products, the CBT developed totally new test procedures, compatible with accepted standard rating tests but expanded to measure the efficiency--and hence economy-- of the equipment during a season of operation. The result is information which the consumer can use to compare operating costs of competitive products.

Both Centers work with the private sector in doing those things which it cannot do for itself. When developing the equipment efficiency test procedures, the Center for Building Technology kept industry advised of what was being done and sought industry assistance to make sure that, in addition to being technically correct, the tests could be conducted in industry laboratories. Both Centers work with industry and make possible the more effective utilization of both private and government resources.

continued. . .

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.
HEADQUARTERS: 8224 OLD COURTHOUSE ROAD, VIENNA, VIRGINIA • 703-790-9890
MAILING ADDRESS: P.O. BOX 70 • MERRIFIELD, VIRGINIA 22116

It has been suggested that the programs of the Centers for Building Technology and Fire Research could be conducted economically and equally well by the private sector. Simply put, any such suggestion is wholly without merit, and there are many reasons for that. These include, of course, the expertise found in these Centers, and the credibility of their work as being unbiased. Any industry claim to lack of bias, even though true, would lack credibility. Engaging in certain types of standardization activities is risky business for any industry. Attempts by competitors to reach a consensus are likely to be viewed with suspicion by those agencies of government which enforce the antitrust laws. In many situations, agreements of great value to the public can be made legally only if they are achieved with the assistance of an organization such as the National Bureau of Standards.

Terminating the Centers for Building Technology and Fire Research would be a great disservice to the public. They are of great economic benefit, as well as being vitally important to the health and safety of people in structures of all kinds. They should be continued and their programs should be adequately funded.

We appreciate the opportunity to share our views with you. If we can be of further assistance or if you need additional information, please let us hear from you.

Sincerely,

Donald D. Clark
Executive Vice President

DDC:clg

cc: Kenneth Enscoe

Brick Institute of America 1750 Old Meadow Road, McLean, Virginia 22102 Phone: 703-893-4010

March 28, 1983

The Honorable Doug Walgren
Chairman
House Science and Technology Subcommittee on
Science Research and Technology
2319 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Walgren:

Pursuant to discussions with your staff, I am submitting for the record the enclosed comments of Mr. Alan Yorkdale. Mr. Yorkdale is Vice-President for Engineering and Research here at the Brick Institute. I hope these comments prove useful in preparation of the case to sustain continued CBT and CFR funding.

I would also like to take this opportunity to congratulate you and your staff on the outstanding effort you have thus far put forth in the matter of maintaining the existence of both these valuable NBS programs. Whether in Congress' wisdom the programs are to continue into the next fiscal year or be terminated at the end of the current fiscal year, your very thorough and professional investigation of the matter has at the least assured the occurence of a fair and complete debate. The work of your committee has been of significant help to the building sector and we are indebted to you.

Finally, it should be noted that Mr. Yorkdale's comments not only represent BIA, but also a significant number of organizations which comprise the masonry industry. If I, or other members of the masonry industry may be of further service, do not hesitate to call upon us.

Thank you for your attention to this matter.

Sincerely,

Joel B. Stronberg

Joel B, Stronberg
Director, Government Relations

JBS:lmt
Enclosure

THE NATIONAL AUTHORITY ON BRICK CONSTRUCTION

Brick Institute of America 1750 Old Meadow Road, McLean, Virginia 22102 Phone: 703-893-4010

A Statement by

ALAN H. YORKDALE, P. E.

on behalf of

The Brick Institute of America
and
The Masonry Industry Committee

on

The Center for Building Technology
and
The Center for Fire Research
National Bureau of Standards

before

The Subcommittee on Science, Research and Technology
Committee on Science and Technology
U. S. House of Representatives
Washington, D.C.

March 23, 1983

THE NATIONAL AUTHORITY ON BRICK CONSTRUCTION

Mr. Chairman; Members of the Committee:

My name is Alan Yorkdale, I am a registered Professional Engineer and Vice President for Engineering and Research at the Brick Institute of America. The Institute is a not-for-profit trade association whose members manufacture 85 percent of the brick produced annually in the United States.

In addition to my capacity as Vice President of BIA, I am today in the position of representing members of the Masonry Industry Committee. The Committee is an organization of the various groups which comprise the masonry industry. They include: the Mason Contractors Association of America (MCAA); the International Masonry Institute (IMI); the International Union of Bricklayers and Allied Craftsmen (BAC); the National Lime Association (NLA); the National Concrete Masonry Association (NCMA); the Laborers International Union (LIU); and of course, the Brick Institute of America (BIA).

Before I begin to describe the masonry industry's technical argument for continuation of the National Bureau of Standards Center for Building Technology (CBT), and the Center for Fire Research CFR), I should like to note that the Brick Institute of America is not alone in its support of these two very important programs. Although I cannot speak directly for other building sector organizations, the broad-based industry support enjoyed by both CBT and CFR is an indicator of the importance of the work performed by both these centers. As the building sector is often characterized as a highly competitive and diverse amalgam of small business interests, the unanimity of support expressed by the industry for continuation of these centers' research is especially telling. Among the many groups and organizations who will be joining the Brick Institute of America in its attempt to preserve the NBS programs are: The American Institute of Architects, the Portland Cement Association, the United States Chamber of Commerce, the National Association of Home Builders, the National Association of Home Builders Research Foundation, the National Fire Protection Association, the National Society of Professional Engineers, the American Consulting Engineers Council and the National Forest Products Association.

The argument for maintenance of the NBS programs is not complicated. The Brick Institute and its masonry colleagues believe that:

- CBT and CFR have had a strong and positive influence on the building sector as a whole;
- both Centers are uniquely qualified in terms of personnel and equipment to perform the research required by industry in each of their respective fields;
- research performed at CBT is particularly outstanding for its depth, technical accuracy and thoroughness;
- the findings of CBT research are essential for development of standards which pertain to the building sector, and

- the generic research conducted at these Centers could not otherwise be performed by the private sector. In part, this is the result of the composition of the industry itself. For the most part, the building sector is a loose confederation of small busines interests without a central decision or research capcity. As businesses subjected to the traditional feasts and famines construction cycle, there is precious little capital to be invested on a sufficiently regular basis as to be able to perform the extended research of either of the NBS Centers. It must also be noted, however, that even if the construction industry was as large and monolithic as steel or automobiles, a question of neutrality would remain. Most industrial research is performed under proprietary conditions. As the basis for standards and guidelines, such research must be considered at least a little suspect. As an agency of the federal government whose mission is to serve the consumer rather than the stockholder, the Centers cannot be considered biased in their research approach. This lack of corporate interest cannot be considered lightly for purposes of regulatory efficacy.

In support of these points, I would like to use the Center for Building Technology as an example. Over the many years which the Center has been part of NBS, its work has been considered outstanding by members of the private sector. The results of its work have not only provided invaluable assistance to the standards-setting community, but also has improved the practitioners' understanding of the safety and performance requirements of buildings and building materials and systems. Among CBT's considerable accomplishments may be listed the following:

1. The basic research work in brick and concrete that was incorporated into the various standards used to determine the durability of concrete and brick products.

2. Their outstanding performance in the fields of energy conservation and passive solar energy technology, through development of measurement techniques, standardized test procedures, computer modeling of energy systems and experimental work in the field of thermal mass.

3. Their service to both the nation and the building community in the field of earthquake research and in their support of the Building Seismic Safety Council;

and

4. Their contribution of personnel and services to the numerous technical committees of the professional organizations which serve the building sector in the development and implementation of standards, test peocedures and measurement techniques. This same unselfish dedication of resources has also occurred in the international area through CBT cooperation on the technical committees of such organizations as

International Council for Building Research Studies and Documentation (CIB) and International Union of Testing and Research Laboratories for Materials and Structures (RILEM).

For the purpose of brevity, I will not elaborate upon the equally valuable contributions to building safety of the Center for Fire Research. However, I have appended a list of these accomplishments to my testimony and shall be happy to provide the Committee with any specific documentation it believes would be helpful.

As a part of the building sector, the masonry industry is acutely aware of the effects of federal expenditures on the private credit market. Because of the relationship between federal deficits and mortgage interest rates, the request for continued funding of CBT and CFR is not made lightly. Industry like government must help to find ways to reduce the cost of maintaining the federal structure. Although an across-the-board cut in all federal services would reduce the cost of government, it would do so at the risk of national health. Clearly, distinctions between the numerous federal programs must be made. Reduction of federal budgets must not be seen as an end, but as a means. Economies which do not recognize the mutual needs of decreased deficits and increased industrial activity are false. Termination of CBT and CFR is a decision which gave no attention to either the integral role which these programs play in the continued development of safe and efficient buildings, or to the industry's financial and proprietary inability to continue this work. In its request of Congress to maintain these programs, the construction industry is not asking for funds which would supplant what otherwise would or should be the responsibility of the private sector. Abdication of the federal government from this program will cause major gaps to occur in our knowledge of building technology and fire safety; gaps which will needlessly jeopardize people and property.

The Brick Institute of America and the other constituent organizations of the Masonry Industry Committee therefore suggest that the Center for Building Technology and the Center for Fire Research maintain these programs within the budget of the National Bureau of Standards. Because of the Centers' unique talents and equipment, we further believe that the House of Representatives should, at a minimum, support their colleagues in the Senate and fund these programs at levels equal to FY 1983. It is our recommendation, however, that the full Congress consider the value of increasing the annual budgets of these programs in an effort to reduce their dependency on funding from other federal agencies, i.e., the Department of Energy, and thereby increase their stability to perform the research which so greatly contributes to the technological progress of the building sector.

Mr. Chairman; members of the Committee, this concludes my remarks. At this time, I will be happy to respond to any questions you might have.

Thank you.

jcr

United McGill
Corporation
United Sheet Metal 200 East Broadway, Westerville, Ohio 43081, 614/882-7401, Telex: 245-357

April 7, 1983

Reply to: 12106 Mackell Lane
Bowie, Maryland 20715
Phone: 301/262-8032

Honorable Doug Walgren
Chairman of the Science, Research and Technology Subcommittee
U. S. House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

On behalf of my Company, I would like to take this opportunity to register our continue support of the National Bureau of Standards Center for Fire Research and Center for Building Technology.

As you can see from the enclosed Corporate brochure we are a manufacturer with facilities throughout the United States. Our support for these Centers is based on the need to have a centralized center for fire and building technology. The private sector, of which we are part, is not in a position to step in and fill the void if these Centers were eliminated or reduced drastically. With the press of foreign influences, it becomes even more important to continue these Centers.

Presently, the Center of Fire Research is working on projects that would have direct application to the heating, ventilating and air conditioning (HVAC) field which we are a part. They also serve as a central focus for objective research and development. Additionally, the Center for Building Technology establishes the basis for traceability of performance standards of equipment used in the HVAC field.

I appreciate this opportunity to voice our support for these two vital Centers.

Sincerely,

Jerry Iacouzze /so

Gerald Iacouzze
Liaison & Technical
Services Engineer

GI/so
Enclosure

cc: K. Scott

ASPHALT ROOFING MANUFACTURERS ASSOCIATION 6288 Montrose Road, Rockville, Maryland 20852 (301) 231-9050

April 8, 1983

Honorable Doug Walgren, Chairman
Subcommittee on Science, Research &
Technology
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

The Asphalt Roofing Manufacturers Association (ARMA) appreciates the opportunity to have the ARMA position made a part of the Subcommittee's record on the fiscal year 1984 budget for the National Bureau of Standards. We particularly direct your attention to the ARMA interest in reauthorizing a financial commitment to maintain the Center for Building Technology (CBT) and the Center for Fire Research (CFR).

The Asphalt Roofing Manufacturers Association is the national trade association representing the major manufacturers of asphalt roofing products -- shingles and roll goods. ARMA member companies supply 80% of the roofing needs for America's housing and 60% of the roofing for commercial, industrial and institutional uses.

Continuing research and information results in improvements in construction technology to the advantage of both the industry and the consumer. Therefore, ARMA strongly believes that it is in the best interest of all sectors of the shelter industry -- as well as the consumer -- to reauthorize appropriate budgets for both the Center for Building Technology and the Center for Fire Research within the fiscal year 1984 budget for the National Bureau of Standards. Both these agencies provide unique research capabilities and sources of information which would be most difficult to duplicate in or by the private sector.

The Administration's proposed elimination of funding for the two Centers could cause a void in research and the development of innovative technology presently available through these Centers. It seems to us that the expenditure of the $9 million included in the proposed budget is a sound investment with proven constructive results.

Building research is budgeted at $3.17 million and fire research at $5.89 million. The Laboratory work by the Centers has saved many more dollars than expended and has prevented structural and fire related problems that might have otherwise arisen.

ARMA agrees with your comments expressed in your opening remarks at the Hearing on March 22, 1983:

> "Our preliminary analysis of the budget shows several trends. With respect to the support of basic research, a major turnaround has taken place in the Administration's policy. The feeling that basic research should absorb its share of the cuts being experienced by the other domestic programs has been abandoned in favor of large increases for selected basic research programs. However, those increases are accompanied by an absence of new initiatives in applied research and technology development, and substantial cutbacks in the existing programs in this category. Specifically, several major programs at the National Bureau of Standards, which have had the strong support of this Subcommittee in recent years would be eliminated entirely while some of the initiatives enacted into public law under the Stevenson Wydler Law are not moving forward. Proposed for outright elimination are the Center for Fire Research and the Center for Building Technology. The Fire Research Center was established by legislation which originated in this Subcommittee in 1973. We are not aware of any views from the fire community that this research work can be turned over to the private sector as proposed, and we are very much aware of the value of the research for fire prevention. The Building research Center provides much needed information on a wide range of materials that go into today's modern, residential, office, and industrial buildings. In addition, the need for an independent, high-quality source of advice and analysis on building technology questions was demonstrated when the Kansas City hotel collapse took place, killing scores of people, and the Bureau of Standards was called in to investigate its causes."

The ARMA has been able to provide the industry with technical information which would not have been possible without the testing capabilities and personnel expertise of the Center for Building Technology.

One of our major research efforts was with built-up roofing systems (BUR). Substantial knowledge has been gained about these systems as a result of research efforts assisted by the CBT. As a part of our statement, we have attached a listing of research performed by the Center for Building Technology, some of which ARMA sponsored.

In addition, ARMA maintains an extremely active interest in fire research and technology. Considerable time and effort by the Association is devoted to fire safety working with local and state fire officials. The Center for Fire Research has expertise simply not available on the local level. Testimony by others has specifically cited that it is unlikely any private sector institution or organization could or would provide the research, information and assistance presently available through the CFR. We are quite concerned over the proposal to eliminate the Center for Fire Research.

In conclusion, the Asphalt Roofing Manufacturers Association respectfully requests that the Subcommittee look favorably on our comments. Considering the supporting information which has been made available through the hearings and comment period, as well as the proven "Track records" of the CBT and CFR, reauthorization of the Center for Building Technology and Center for Fire Research is a practical and wise move by the Congress.

We will be delighted to respond with further information as to our experiences with both Centers if such material will be helpful in your deliberations and in support of the budget reauthorization.

Sincerely,

Richard D Snyder

Richard D. Snyder
Executive Vice President

RDS/kg

LISTING OF

ROOFING RESEARCH PROJECTS
PERFORMED BY

THE NATIONAL BUREAU OF STANDARDS

April 8, 1983

STATE-OF-THE-ART OF STRUCTURAL TEST METHODS FOR WALLS, FLOORS, ROOFS, AND COMPLETE BUILDINGS NBS Building Science Series 58
C.W.C. Yancey and L.E. Cattaneo
U.S. DOC/NBS Issued November 1974

Information of the structural testing of building components for the purpose of documenting information applicable to structural test method development and what research is needed for improvement of present test practice.

THE PERFORMANCE OF ROOFING MADE WITH ASPLUND FELTS
NBS Technical Note 477
S.H. Greenfeld
U.S. DOC/NBS Issued March 1969

Study of durability and performance of roofing made with Asplund wood fibers.

ATMOSPHERIC EMISSIONS FROM ASPHALT ROOFING PROCESSES
R.W. Cerstle; PEDCo-Environmental, Inc.
Prepared for National Environmental Research Center
Distributed by: NTIS/U.S. DOC October 1974

Description of asphalt roofing manufacturing processes and types of air pollution control devices applied to them.

PROPERTIES OF 21 YEAR OLD COAL-TAR PITCH ROOFING MEMBRANES: A COMPARISON WITH THE NBS PRELIMINARY PERFORMANCES CRITERIA
R.G. Mathey & W.J. Rossiter, Jr.
U.S. DOC/NBS Issued June 1977

Properties of coal-tar pitch roofing membranes approximately 21 years old were compared to properties of new membranes on buildings subjected to different maintenance procedures.

INTERIM REPORT ON PROJECT 4847 STANDARDS FOR BUILT-UP ROOFS
National Bureau of Standards Report 5422
W.C. Cullen, L.R. Kleinschmidt, H.R. Snoke
U.S. DOC/NBS Issued ?

Results of field studies of 101 low-pitched, mineral-surfaced, asphalt and coal-tar pitch, built-up roofs in the Western, Mid-Western and Eastern States.

NATURAL WEATHERING OF MINERAL STABLIZED ASPHALT COATINGS ON ORGANIC FELT NBS Building Science Series 24
U.S. DOC/NBS Issued October 1969

Study of long term outdoor weathering and the effects of mineral additives on the durability of coating-grade roofing asphalts.

HAIL RESISTANCE OF ROOFING PRODUCTS
Building Science Series 23
S.H. Greenfeld
U.S. DOC/NBS Issued August 1969

An evaluation as to the hail resistance of roofings.

THE EFFECT OF MOISTURE OF THE HEAT TRANSFER PERFORMANCE OF INSULATED FLAT-ROOF CONSTRUCTIONS NBS Building Science Series 37
F.J. Powell & Henry E. Robinson
U.S. DOC/NBS Issued October 1971

I. How much insulating performance of conventional constructions having insulation over concrete decks, was affected by moisture.
II. Investigation of properties of materials, their arrangement and dimensions which would yield a construction having an adequate degree of self-drying ability combined with low winter moisture regain rate.

EFFECTS OF MOISTURE IN BUILT-UP ROOFING - A STATE-OF-THE-ART LITERATURE SURVEY NBS Technical Note 965
H.W. Busching, R.G. Mathey, W.J. Rossiter, Jr., W.C. Cullen
U.S. DOC/NBS Issued July 1978

Review of literature which describes performance of roofing materials and systems as they are affected by moisture.

SOLAR HEATING, RADIATIVE COOLING, AND THERMAL MOVEMENT - THEIR EFFECT ON BUILT-UP ROOFING NBS Technical Note 231
W.C. Cullen
U.S. DOC/NBS Issued December 1963

Presents temperature data on several built-up roof systems when exposed to natural solar heating and radiative cooling during summer and winter seasons in Washington, D.C. and discussion in terms of roof performance. Furnishes data on thermal expansive and contractive characteristics of a composite built-up membrane and relation of these to performance of roof membrane.

LUBBOCK TORNADO: A SURVEY OF BUILDING DAMAGE IN AN URBAN AREA
NBS Technical Note 558
N.F. Somes, R.D. Dikkers & T.H. Boone
U.S. DOC/NBS Issued March 1971

Survey of building damage in the aftermath of tornado which hit Lubbock, Texas with conclusions as to reducing damage observed.

HURRICANE CAMILLE: AUGUST 1969 NBS Technical Note 569
R.D. Dikkers, R.D. Marshall
U.S. DOC/NBS Issued March 1971

Survey of structural damage caused by Hurricane Camille and suggestions as to improvement of building design and construction practices.

THERMAL-SHOCK RESISTANCE FOR BUILT-UP MEMBRANES
Building Science Series 9
W.C. Cullen & T.H. Boone
U.S. DOC/NBS Issued August, 1967

Laboratory data on some engineering properties of conventional bituminous built-up membranes and relations to performance desired of roofing systems operating under service conditions.

LABORATORY-FIELD COMPARISONS OF BUILT-UP ROOFING MEMBRANES
NBS Technical Note 473
T.H. Boone, L.F. Skoda & W.C. Cullen
U.S. DOC/NBS Issued December 1968

Comparison of values of engineering properties and thermal-shock resistance factor of roofing specimens under closely controlled lab conditions with technicians and under job-site conditions with roofers.

FATIGUE TESTS OF BITUMINOUS MEMBRANE ROOFING SPECIMENS
NBS Technical Note 863
G.F. Sushinsky & R.G. Mathey
U.S. DOC/NBS Issued April 1975

Measurement of the tensile and flexural fatigue strengths of conventional roofing membranes, develop methods of tests for measuring these engineering properties and recommend levels of performance.

PRELIMINARY PERFORMANCE CRITERIA FOR BITUMINOUS MEMBRANE ROOFING
NBS Building Science Series 55
R.G. Mathey & W.C. Cullen
U.S. DOC/NBS Issued November 1974

Research to identify and describe quantitatively the attributes which would be required of bituminous membrane roofing to assure their adequate performance in the varied climates of the U.S.

HAIL RESISTANCE OF ROOFING PRODUCTS NBS Report 9871
S.H. Greenfeld
ARMA/U.S. DOC/NBS Issued July 1968

An evaluation as to the hail resistance of roofings.

PROGRESS IN THE DEVELOPMENT OF A THERMAL-SHOCK RESISTANCE FACTOR FOR BITUMINOUS BUILT-UP ROOFING MEMBRANES (Paper 169)
W. C. Cullen & T.H. Boone
NBS Issued 1966

Lab data on some engineering properties of conventional bituminous built-up membranes and relate this data to the performance desired of roofing systems operating under service conditions.

THERMAL RESISTANCE MEASUREMENTS OF A BUILT-UP ROOF SYSTEM
NBSIR 80-2100
S.J. Treado
U.S. DOC/DOE Issued October 1980

Identification of factors which affect the thermal performance of existing built-up roof systems and description of technique for measuring the thermal resistance of roof systems.

SLIPPAGE OF BUILT-UP ROOF MEMBRANES - CAUSES AND PREVENTION
NBS Report 10,950
A.P. Cramp, W.C. Cullen, M. Tryon
U.S. DOC/NBS Issued November 1972

Results of laboratory research as well as field observations of membrane slippage in service; causes of slippage; suggestions on reducing the incidence of slippage.

A STUDY OF THE VARIABLES INVOLVED IN THE SATURATING OF ROOFING FELTS
Building Science Series 19
S.H. Greenfeld (ARMA)
U.S. DOC/NBS Issued June 1969

The study of degree of saturation of #27 felt with a typical roll saturant and a #55 felt with roll, mixed and shingle saturants.

EFFECT OF INSULATION ON THE SURFACE TEMPERATURE OF ROOF MEMBRANES
NBSIR 76-987
W. J. Rossiter, Jr., R.G. Mathey
U.S. DOC/NBS Issued February 1976

Study of surface temperature of black, grey and white roofs containing various amounts of insulation.

THE VISCOSITIES OF ROOFING ASPHALTS AT APPLICATION TEMPERATURES
NBS Building Science Series 92
W.J. Rossiter, Jr. , R.G. Mathey
U.S. DOC/NBS Issued December 1976

To develop a viscosity criterion for the application of asphalt in the fabrication of built-up roofing membranes.

MATERIALS FOR BUILT-UP ROOF COVERINGS STANDARD FOR SAFETY UL 55A
U/L Issued August 1978

Basic safety requirements for products covered by U.L. in the category of built-up roof coverings.

GUIDELINES FOR THE INSTALLATION OF SOLAR COMPONENTS ON LOW-SLOPED ROOFS NBS Technical Note 1134
R.G. Mathey, W.J. Rossiter
U.W. DOC/NBS/DOE Issued November 1980

Installation of solar equipment on existing low-sloped roofing systems, attachment to roof and wind uplift, evaluating existing roofing condition. Some guidelines applicable to installation on new roofing systems.

BUILDING RESEARCH AT THE NATIONAL BUREAU OF STANDARDS 1968-1974
NBS Building Science Series 75
N. Gallagher
U.S. DOC/NBS Issued March 1979

Description of changes that took place in National Bureau of Standards building research activities from 1968-1974.

UNDERWRITERS LABORATORIES INC.
333 PFINGSTEN ROAD · NORTHBROOK, ILLINOIS 60062

an independent, not-for-profit organization testing for public safety

March 8, 1983

The Honorable Douglas Walgren
Chairman, Subcommittee on Science,
Research and Technology
U. S. House of Representatives
Washington, DC 20515

Subject: Underwriters Laboratories Inc. (UL) Commentary in Opposition to the Elimination of the National Bureau of Standards (NBS) Center for Fire Research (CFR) as Related to Proposed Department of Commerce (DOC) Fiscal 1984 Budget Reductions.

Dear Mr. Walgren:

This is pursuant to recent telephone conversations with your assistant Ms. Carrye Brown. We thank you for the opportunity to comment on the proposed 1984 budgetary cuts which would result in the elimination of the Center for Fire Research of the National Bureau of Standards. We recognize the necessity to seek ways to reduce the mounting Federal deficits and appreciate the hard choices faced by Congress and the nation, but the elimination of the CFR would be a severe setback to the goal of reducing deaths, injuries and property damage from fire.

UL is an independent third party laboratory providing testing evaluation, inspection and product marking services for electrical and mechanical products, building materials, construction systems, fire protection equipment, and marine products to determine that the design and performance of such products provide for reduction of the risk of injury to persons and damage to property during use; to identify such products through a system of marking that permits recognition by consumers, authorities having jurisdiction, and others; and to establish, through contractual arrangements with manufacturers for UL's audit (inspection) of production, conformance of products with applicable requirements contained in UL's Standards for Safety and/or the standards of other nationally recognized organizations.

Our position on this matter is based upon a close association with the work of the NBS in the area of fire research dating back to the early stages of this science over 70 years ago. UL's beginning dates back to 1894. Contact between UL and NBS dates back to the early part of this century and included early research and test development work on fire protection building elements, i.e., doors, walls and columns. The availability of comprehensive fire test method development facilities and staff capabilities at the NBS has provided an important, unbiased centralized service to UL and U.S. industry, as well as governmental agencies, for decades. The NBS program draws on the expertise of the private sector through a myriad of communication modes including grants, research contracts, seminars, symposia, formal meetings, mutual participation in national and international technical committee activities and research associate and personnel exchange programs.

The composition of the fire community in the U.S. is widely diversified, including scientists, engineers, fire professionals, regulators, testing laboratories, product performance certifiers, architects, builders, manufacturers and users. This diversity requires the existence of a central organization to coordinate the research carried out toward the development of new fire test methods and technologies for use by product testing organizations, certifiers and regulators. This coordination is an essential element in the fire safety system used in the U.S., particularly since the safety of the public is at stake. The NBS-CFR has served as a stable central source for reliable research of fire test methods and technologies, using specialized equipment and highly and uniquely qualified personnel, that could not otherwise be brought together within the private sector even if funding could be made available. A truly significant void would be left if the NBS-CFR program is eliminated in its present form. Many, if not all, of the research services provided by the NBS-CFR would never again positively impact on the testing of products requiring fire evaluations.

Consideration of the diversification of the NBS-CFR program provides insight into its scope and over-all impact on fire protection in the U.S. NBS-CFR conducts or supports research in the following areas now specifically requiring the development of scientific knowledge:

Basic fire phenomena such as ignition, fire spread, smoldering fires, radiation fires and soot formation.

Comprehensive work in the development of combustion products toxicity and smoke generation and movement test methods - two primary elements of a fire risk assessment.

Development of effective, economical high-rise building fire protection systems - encompassing the complex combination of fire suppression mechanisms (sprinklers, etc.), smoke control methods, fire detection (smoke and heat detectors) interior finish materials (fire spread resistance) and construction materials and assemblies (fire rated walls, floors, ceilings and columns).

Development of computer-based fire simulation and prediction methods - a successful future in fire science, research and technology in the U.S. may very well depend on such a comprehensive program for designing buildings through computer-based methods.

The five year program initiated at the NBS-CFR to develop a quantified system for evaluating the nation's progress toward reducing fire deaths and property losses on a goal-oriented basis was unique and would not likely have been carried out elsewhere within the government or in the private sector. If the CFR program had not existed, this unique system might have been delayed or never developed. The over-all economic advantages of this system have yet to be fully measured but it can be said that in the long range, the cost savings alone could justify the continuation of the NBS-CFR. This and many other unique efforts of the NBS-CFR would probably not have even been undertaken in the private sector, or simply could not have been efficiently funded since in many, if not all instances, these efforts are oriented toward the widely divergent interests mentioned earlier rather than to a single interest.

The NBS-CFR has served an important allied research function on the development of fire test methods used extensively by the private sector in establishing compliance with prevailing National Codes and Standards. Specific examples of these joint NBS/UL cooperative efforts include:

Fire performance and wind resistance testing of building roof coverings.

Surface burning characteristics of interior finish building materials.

Smoke movement through doors, dampers and windows in buildings.

Smoke detector testing and sensitivity evaluation techniques.

Smoke generation testing methods for building materials.

Large-scale fire research testing to measure the effectiveness of large-scale test methods.

Computer-based fire modeling techniques.

The nation must continue to have the benefit of the coordination and unbiased evaluation of the fire sciences, research and technology being used to protect its citizens offered by the NBS-CFR program. The mission of the NBS-CFR must transcend budgetary concerns for it represents a program aimed at reaching one of the highest goals set down for any elected administration, namely, to "promote the general welfare."

We urge those in government responsible for the fiscal 1984 DOC budget to take whatever steps are necessary to continue the high priority program of the NBS-CFR in operation.

We appreciate the opportunity to express our views on this most important matter.

Sincerely,

Jack Bono

JACK BONO
President

JAB:AGA

G.T. Castino

G. T. CASTINO
Assistant Vice President
and Chief Engineer -
Fire Protection

NFPA®
"Moving Mankind Toward Safety From Fire"

NATIONAL
FIRE PROTECTION
ASSOCIATION
INTERNATIONAL

STATEMENT CONCERNING THE PROPOSED ELIMINATION OF THE CENTER FOR FIRE RESEARCH WITHIN THE NATIONAL BUREAU OF STANDARDS

submitted to the

Subcommittee on Science, Research and Technology
Committee Science and Technology
United States House of Representatives

by the

National Fire Protection Association
Batterymarch Park
Quincy, Massachusetts 02269

March 16, 1983

EXECUTIVE OFFICE: BATTERYMARCH PARK, QUINCY, MASSACHUSETTS, U. S. A. 02269 • TELEPHONE (617) 328-9290 • TELEX 94-0720

The non-profit technical and educational organization: To promote the science and improve the methods of fire protection and prevention; to obtain and circulate information on these subjects and to secure the co-operation of its members and the public in establishing proper safeguards against loss of life and property by fire.

The National Fire Protection Association (NFPA) expresses its concern over the Administration's FY'84 budget proposal that would provide zero funding for the Center for Fire Research (CFR) within the National Bureau of Standards (NBS) and, thus, eliminate this important scientific research unit within the Federal Government.

The NFPA, founded in 1896, is a non-profit, technical and educational membership organization. It has remained the principal public advocate for fire safety since its inception. The Association's membership of over 32,000 is drawn from the many disciplines involved in, and concerned about, the national fire problem. NFPA is not a trade or industry association. No one group or interest is dominant. The only common membership denominator is a concern about fire safety. Members include fire service personnel, fire marshals, electrical inspectors and city managers; architects, engineers and educators; health care facility operators and similar groups from commerce, industry, insurance and the Federal Government. The NFPA is best known for its voluntary safety standards, collectively known as the National Fire Codes which, in whole or in part, are incorporated by reference into numerous federal and state laws and into municipal ordinances.

The proposed elimination of the NBS Center for Fire Research follows the Administration's FY'83 proposal to eliminte the United States Fire Administration (USFA), which is presently located within the Federal Emergency Management Agency.

Thanks to action by the oversight and the appropriations committees, although curtailed and redirected, the USFA was saved. This year the elimination of the Center for Fire Research is being proposed at the same time that reauthorization for the USFA is being sought.

In NFPA's view, the existence and continued functioning of both the USFA and the NBS Center for Fire Research is essential. Historically, the NBS has had a fire research capability since 1904, at which time standardization of fire hose couplings was at issue. In subsequent years, the Fire Resistance Section had been established within NBS, and in 1968, with the enactment of the Fire Research and Safety Act of that year, the organization was formalized. Subsequently, Section 18 of the Fire Prevention and Control Act of 1974 amended the NBS Organic Act thereby creating the Center for Fire Research in its present form.

It would be a mistake to view the workings of the NBS Center for Fire Reserach as simply abstract, scientific experimentation. Although the Center is a community of scientists and engineers and much of the work is, in its initial form, relatively abstract, one of the distinguishing features of this particular part of NBS is that the Center goes beyond this initial research to produce practical tools that have great benefits.

For example, the Center began fundamental studies of residential smoke detection in 1972. At that time, home smoke alarms were virtually unknown in this country. Two years later, a test method for residential detectors was published by NBS and adopted by Underwriters Laboratories as the basis for that organization's certification and labeling program. These developments set the stage for the explosion of smoke detector sales in this country. Now, less than ten years after the Center's first inquiry, two out of every three homes in the United States has this life-saving device. In NFPA's judgement, that would not be true if it weren't for the pioneering work of the Center for Fire Research.

One reason we feel safe in most buildings is that we are fairly confident that a fire will not cause them to collapse before we can get out. Buildings don't just happen to be built that way -- the concepts of fire endurance, which are the bedrock of modern fire protection, were developed at NBS fifty years ago.

When you go home this evening, take a moment to look at your carpet; work completed at NBS in 1970 has ensured that carpet manufactured since that time will not ignite from a dropped match or similar small ignition source.

No mattresses sold legally since 1973 will ignite from a cigarette -- again thanks to work done at NBS.

There is scarcely an area of practical fire protection which does not show the imprint of work done by the Center. Fire fighters today wear improved protective clothing; buses, subways, trains and airplanes are more fire safe; hospital and nursing home fires are increasingly uncommon -- all due to research done and put to practical end use as a result of the work of the Center for Fire Research.

NFPA doesn't think anyone can seriously suggest that the Center doesn't earn its keep -- a single famous hospital in Massachusetts saved more money by applying CFR-developed fire protection technology than it costs to operate the Center for eighteen months. Rather, the issue is whether the private sector can do as well or better in providing this technology. In our view, it cannot -- in fact, it can't even come close.

It takes money to do this work, and in the private sector, one cannot spend money unless there is a clear financial return. Safety standards, such as those of NFPA, invariably involve product exclusions. This means that the research that often underlies the standard must be technically sound and free from bias. Even when privately funded research meets these tests, the conflict level that accompanies standards development will be raised. That level is already high, and the risk is run of having fire safety being finally determined in the courtroom, not the laboratory. By the same token, the costs of standards development would increase dramatically.

The crucial and irreplaceable element that NBS brings to the fire safety community is credibility. Private funds doing the same research, just as well, could not have the same impact.

Furthermore, the Center is an interdisciplinary organization. No single industry would be willing to support such a diverse collection of specialties. Yet, without that diversity, the breakthroughs are not going to be realized.

For example, mention was made that the Center had developed cost-saving technology for hospitals. That involved the concept of the Fire Safety Evaluation System (FSES) for Hospitals and Nursing Homes, a concept that is now also part of the National Fire Codes. Using this system, building owners and developers can meet code requirements with far more flexibility and, therefore, at much lower cost than was previously the case. The savings potential for health care facilities alone in the United States is in the billions -- and comes at a time when other health care costs are skyrocketing. On one hand, the Center had assembled the physicists, psychologists and engineers to compare and evaluate fire protection methods and, on the other, the Center had the credibility in the building and regulatory community to gain review and acceptance of the concept from those who would use it day-to-day.

In summary, considering the highly-charged nature of the work done by the Center for Fire Research, it is absolutely essential that this work continue within government, and not in the private sector, as this possibility is being proposed by the Administration. It cannot be transplanted effectively; and it cannot be transplanted at all without creating a vacuum in essential independent research and opening a door to judicial challenges.

Further, the locus of the Center for Fire Reserach within the NBS, and not in some other government agency, is fully justified because of the universal recognition of NBS' scientific stature and because of the beneficial synergistic effects that comparison and correlation with other scientific disciplines in NBS provides. Not one university or private research institution in the United States is able to provide this inter-disciplinary approach.

As we are sure the Subcommittee will realize, the Center's work products not only benefit the NFPA, but also underlie much of the private sector's product certification activities.

To emphasize our point once again, even if the NBS Center for Fire Research could be physically duplicated within the private sector, the credibility of such an entity would be far less than that of the existing NBS organization. Much more can be said on this subject, and we have tried, in an attachment to this statement, to deal briefly with a few of the most important aspects of the question: "What if the CFR is shut down?"

The NFPA also supports fully the work of the NBS Office of Product Standards Policy which, at present, supports private sector standardization initiatives and performs a valuable function in both international and domestic standardization, product certification and accreditation of testing laboratories.

In conclusion, the NFPA urges the Subcommittee on Science, Research and Technology to recommend continuation of the Center for Fire Research at the FY'83 funding level.

Attachment

WHAT IF THE CFR IS SHUT DOWN?

1. Combustion toxicity is an issue where the CFR is required.

The tremendous public debate over combustion product toxicity is one in which there is almost no neutral ground. Those responsible for public safety get facts from combustible materials industries on one side, and those who make non-combustible products on the other. While there may be valid points on both sides, regulators are poorly equipped to determine which materials are fact and which are simply self-serving in this complex area. The Center is the only credible source of technical information and, hence, occupies the only neutral ground in a hotly contested arena.

Neither NFPA nor the two largest independent fire testing laboratories have any biological testing capability. Several smaller testing laboratories do, but they are all already trying to sell their particular tests, so it's hard to see who would fill the need for neutrality. Yet, if the laboratory is not funded, near anarchy could result.

2. Private sector not equipped to pick up work of the CFR.

As part of NBS, the Center for Fire Research's job is to develop methods to measure fire performance and to help decide what level of performance is needed. By contrast, industry provides proprietary products and services. In fire protection, these proprietary products usually must meet specific requirements -- requirements that are often set based on work done by the

Center. At present, NBS and the private sector do not compete, but perform complimentary functions.

If the Center were to be abolished, the private sector would have to take on the role of umpire where now it is a participant in the game, and this raises a potential for severe conflict of interest.

3. Other countries have national fire reserach laboratories.

Most Western European countries, Canada and Japan have government-supported fire research laboratories. (Even China and the Soviet Union have such organizations.) Although input from the private sector is encouraged, in no case is the responsibility for code-related research left in the hands of industry.

4. Center supports most fire research in this country.

If funding is halted for the Center, virtually all fundamental research in fire would cease. This is because the Center supports all of the university-based research in the area, as well as its own in-house program.

Therefore, shutting down the CFR shuts down more than an organization -- it shuts down an entire area of science.

5. Rebuilding capability at the CFR is not readily done.

In addition to its operating budget, the Center has perhaps $10 million in equipment and facilities, most of it immovable.

If the private sector were to assume the role now played by NBS, NBS would either have to make these facilities available to tenant researchers or the facilities would have to be duplicated elsewhere.

Where testing is routine, private laboratories already duplicate a portion of these facilities and carry out testing on a business basis. For example, Underwriters Laboratories uses a number of CFR-developed tests as part of its listing services.

The development of test methods and criteria involves a breadth of staff and facilities that even the largest private labortories do not possess. It is obviously more cost-effective for NBS, using existing laboratory facilities, to continue developing test methods than for several laboratories, independently, each to build such facilities.

ahca
American Health Care Association 1200 15th Street, Washington, DC 20005 (202) 833-2050

April 14, 1983

The Honorable Doug Walgren
United States House of Representatives
Washington, DC 20515

Dear Mr. Walgren:

The American Health Care Association (AHCA), a national association of long term care providers representing 8,000 nursing homes and allied facilities, urges the Subcommittee on Science, Research and Technology to recommend reauthorization of the National Bureau of Standards' Center for Fire Research. AHCA fully supports the work of the Center for Fire Research and disagrees with the Administration's position that the Center's research activities will be taken up by the private sector.

AHCA has actively been involved during the last 12 years in promoting fire safety in nursing homes and board and care facilities. It is in this role that AHCA has worked with NBS' Center for Fire Research. Without question the elderly of our nation and the long term care industry has greatly benefitted from the work of the Center.

The fire record of the industry has significantly improved in recent years to such a degree that there has not been a major life loss fire in a nursing home in the last six years. This dramatic improvement in the fire safety record is due to the combined efforts of the industry, the regulatory authorities and the fire research community. The Center for Fire Research has singularly conducted more work in the area of health care fire safety than the entire private sector has done in total. In its basic fire research and development of fire testing methodologies and its development of practical day-to-day tools for the industry (such as the Fire Safety Evaluation System for Health Care Facilities), the Center provides the necessary foundation on which we must continue to build to assure the protection of the nation's elderly and infirm.

The Center for Fire Research brings to the fire protection and the health care communities something that no other organization can -- credibility and objectivity. It is the opinion of AHCA that the private sector cannot and will not obtain a similar credibility and objectively status.

In summary, AHCA strongly recommends the reauthorization of funds for the continuation of the Center for Fire Research. The United States has in place an existing excellent fire research activity that AHCA belives cannot and will not be replaced by the private sector.

Sincerely,

Douglas G. Pendergras

Douglas G. Pendergras
President

DGP/TJ:ac

CRI
The Carpet and Rug Institute, Box 2048, Dalton, Georgia 30720 (404) 278-3176

Ronald E. VanGelderen
President

April 4, 1983

RECEIVED
APR - 8 1983
COMMITTEE ON SCIENCE
AND TECHNOLOGY

The Honorable Don Fuqua
House Committee on Science and Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Sir:

The Carpet and Rug Institute recommends that full funding for the National Bureau of Standards Center for Fire Research be reinstated.

Responsible fire research is essential. NBS has earned a reputation over the years which garners acceptance with objectivity. Presently the problems of fire safety are being confused by the myriad of testing laboratories, consultants and well-meaning consumer advocates. The fire research which is being conducted by industry and academia is frequently fragmented, lacks equipment and expertise, and cannot compare to the concentrated effort which has taken place at the NBS.

Although we are basically for "less government," we feel that one of the most important functions of the NBS is its contribution in the area of fire safety, toxicity, etc. The valuable research at the Center for Fire Research has been a factor in leading the decline of fire deaths and their input is needed to continue the decline. It is difficult to place a dollar value on an individual's life, but a 25 percent decline in the past decade would appear to more than justify the money which has been appropriated for fire research.

These issues are very much in the public's eye right now and we feel that it would be ill-timed to discontinue funding this very important function. In fact, the scope of involvement should be expanded to include fires in homes. Most lives are lost in residential dwellings but little research is being conducted to reduce this hazard. Fires in public buildings or high density occupancy buildings receive all the notoriety, yet the residential fire hazard problem needs far more attention.

Our industry has been particularly impressed by the Center for Fire Research when protocols were developed in coming up with acceptable standards for carpet flammability - a serious issue ten years ago and now a requirement taken for granted by the public. It is an example of responsible action by NBS and the Center for Fire Research. We urge the Committee on Science and Technology to restore FY-1984 funding for the NBS Center for Fire Research at levels which will permit this valuable work to continue.

Very truly yours,

Ronald E. VanGelderen

Ronald E. VanGelderen

REV:pup
cc: The Honorable Ed Jenkins
The Honorable Larry McDonald

allied
TUBE & CONDUIT
CORPORATION

March 22, 1983

STATEMENT OF ALLIED TUBE & CONDUIT CORPORATION

Submitted to the
SCIENCE, RESEARCH AND TECHNOLOGY SUBCOMMITTEE
of the
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

Allied Tube and Conduit Corporation wishes to register its strong exception to and serious concern over the Administration's proposed elimination of the Center for Fire Research at the National Bureau of Standards. This would be the result of the Administration's decision not to authorize any funds for the Center for Fire Research in the Commerce Department's budget for fiscal year 1984.

Allied manufactures and markets electrical conduit, sprinkler pipe, and a variety of other products made from steel. Allied is especially interested in minimizing the fire hazards associated with building materials.

The Subcommittee has heard and read the statistics regarding fire-related injuries and deaths; its members are aware that this country's record is among the worst in the industrialized world when it comes to preventing death, injury and property destruction by fire. There is a great deal of urgent work to do in this area -- and the Center is clearly one of the most important places to do it.

16100 SOUTH LATHROP HARVEY, ILLINOIS 60426 (312) 339-1610, CHICAGO 955-6000 TELEX 25-4352

Current projects of the Center include the design of smoke control systems, the development of fire safety evaluation systems, testing and development of residential sprinklers, fire modeling, and research regarding arson, heating appliance fires and basic combustion. The Center also operates a fire research grant program to encourage the development of scientists and engineers in fire research and safety, a fire research information center, and an annual conference on fire research, in addition to participating in voluntary standards organizations and in the international fire safety community.

One of the most complex and significant questions in fire safety research today involves the toxicity of smoke and gases given off by many of the materials that are used in today's building construction and furnishings. The Center is in the forefront of the research efforts that are urgently needed for us to appreciate fully the extent of this problem and to develop the most effective measures to deal with it.

In the mid-1970's, while perfecting a test methodology for residential smoke detectors (one of the most important fire-safety breakthroughs of the decade), the Center also determined that the possible lethal effects of toxic fumes emitted from the ever increasing number of synthetic materials that are finding their way into our modern-day construction and furnishings, warranted a major research effort on its part.

The gravity of this particular subject has recently been underscored by the rash of fire disasters in hotels and other high-density structures that we have seen in recent years.

The efforts of the Center have resulted, thus far, in the development of a test protocol that has raised serious questions about the toxicity of polyvinyl chloride and other polymeric materials relative to untreated wood. To be sure, there is a need for further refinement of this test protocol and for the development of an acceptable rating system for such building materials and furnishings. There are complex technical issues involved that clearly need the independent expertise of the Center. Last year, Congress registered its concern when, in December, it appropriated an additional $350,000 to enable the Center to continue this important research on combustion toxicity.

Just last month, the president of the Uniformed Fire Officers Association told New York State's Fire Prevention and Building Code Council that the use of plastics and other synthetic materials in high rise office buildings makes those structures "gigantic toxic time bombs. . . Should a fire strike," he said, "it would be disastrous. Even if . . . people could have escaped safely, the toxic fumes from burning plastics and other synthetics would kill them." Prophetically, on the very day these remarks were reported, 64 people died in a fire in Turin, Italy. United Press International reported the tragedy as follows:

> Poisonous fumes emitted by burning plastic seat covers turned a movie theater into a "spectacular gas chamber" that choked to death most of the 64 victims of the cinema blaze, investigators said . . .
>
> "There were no high tongues of flame that destroy everything in a brief space of time," Fire Chief Giuseppe Marini said. "But there was a great quantity of smoke containing not only anhydrous chemicals, carbon dioxide and ashes but also other poisonous gases produced by the decomposition of material from which the cinema furnishings were made."

Last November, toxic fumes from a fire in a single Mississippi jail cell killed 27 and injured 61 elsewhere in the building. The list of such disastrous episodes is an alarmingly long and steadily growing one. Suffice it to say there is mounting evidence and recognition that combustion toxicity is a major fire safety problem that needs the continued research focus of the Center.

Also, the Center's research efforts must not be abruptly halted because it is a research institution that all those who are involved with the complex problem of combustion toxicity have accepted as an objective, credible source of scientific knowledge in this area. That the consequences of toxicity research also will have a commercial impact on the many competing forms of construction and furnishing materials -- including steel and plastics -- is itself an important reason to safeguard the Center's acknowledged neutral expertise.

The Administration has rationalized its proposed elimination of the Center by suggesting that the private sector will, in one way or another, take up the Center's work. Just last week, however, this Subcommittee heard authoritative testimony to the contrary. One of the country's largest private-sector fire research organizations, Factory Mutual, noted that "the basic fire research effort of the nation consists almost entirely of the Center for Fire Research effort, some university programs supported by the Center for Fire Research, and our own effort. . . . If the Center for Fire Research disappeared, it is probable that our basic effort would disappear too." At the same hearings, the National Fire Protection Association testified that:

> The crucial and irreplaceable element that NBS brings to the fire safety community is credibility. Private funds doing the same research, just as well, could not have the same impact.

Scientific quality, practicality, objectivity and neutrality have been the hallmarks of the Center. There is simply no evidence that the private sector is inclined even to attempt to fill the vacuum that would be left in the area of basic fire research if the Center were to be eliminated.

The Administration also attempts to justify shutting down the Center on the basis that fire safety is more appropriately a matter for state and local governments. This claim misses the point. It is true that fire prevention, regulation and, of course, firefighting are primarily matters for local jurisdictions. The federal government, however, does have a significant role to play in assisting local jurisdictions with their work. For example, the U.S. Fire Academy instructs local firefighters in the latest methods of fire suppression. Last year, it was this institution that was targeted by the Administration for extinction. Congress rejected the attempt. This year, having lost last year's fight, the Administration has reversed its previous position by supporting the continued funding of the U.S. Fire Academy, but has focused on a new target, the Center. With this nation's fire safety record, both institutions provide essential federal support for effective local fire prevention and regulatory efforts and must, therefore, be continued.

To be sure, state and local governments already have focused on the problem of combustion toxicity and have undertaken their own efforts to deal with this subject. They will continue to do so and many more, no doubt, will be joining them in the future. It is, therefore, imperative that the resources and objectivity of the Center be available, when the need arises, to assist these local governments with their efforts to regulate responsibly in this area.

The previously mentioned involvement of the Center in the development of the smoke detector -- probably the single most important piece of fire-safety equipment in the average American home -- is illustrative of the assistance that the Center provides. Smoke detectors now are required by many local fire codes for many different structures, and they are encouraged in an increasing number of jurisdictions through differentiated fire insurance rates. A decade ago few American homes had such devices. That an estimated two-thirds of this country's households now have this inexpensive life-saving alarm is due, in large measure, to the work of the Center which developed the first universally accepted test methodology for certifying acceptable residential smoke detectors. This facilitated their acceptance into the mainstream of American life.

In sum, we urge the Subcommittee on Science, Research and Technology to restore the Center's budget authorization at its fiscal year 1983 level. As the Subcommittee is aware, the Science, Technology and Space Subcommittee of the Senate Committee on Commerce held hearings on the Center and related topics exactly one month ago on February 22. Indeed, many of the witnesses now appearing before this Subcommittee also were present at the Senate Subcommittee hearings. With the exception of those witnesses whose job it is to present the Administration's view, praise and support for the Center has been unanimous. Senator Gorton already has introduced a bill that would restore the Center's budget authorization. We hope similar action on the House side will result from this Subcommittee's inquiry.

MAR 21 1983

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CHARLIE W. JONES
President

March 18, 1983

The Honorable Doug Walgren
Chairman
Subcommittee on Science, Research
and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

I am writing to express our concern about the fact that the 1984 federal budget contains no funds for the Center for Fire Research at the National Bureau of Standards (NBS).

Over the years, the Center for Fire Research has developed an outstanding reputation. It has been the center for development of meaningful and relevant test methods to determine overall combustion properties of many textile products.

The Center for Fire Research has made valuable contributions to a better understanding of the complex fire phenomenon and how materials burn. In addition, the Center has recently completed development of a laboratory test method for research purposes to determine toxicity of combustion products. The Bureau recognizes the limitations of this test and the need for continuing research to determine the relationship of the laboratory test methods to real fire situations.

The work of NBS has resulted in the general agreement among fire experts and industry that the most cost effective means of providing life safety and protection of property is the greater use of installed automatic sprinklers and early warning systems. The Center is continuing to more fully explore the applications of new sprinkler technology and cost effective installation of such systems in all types of occupancies.

We believe it is essential that these kinds of investigations be continued by the Center for Fire Research since the Bureau is looked upon by standard writing groups, code officials and fire service personnel to provide leadership, guidance and uniformity in providing meaningful standards concerning fire which is of national

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American Enka Co.
Amoco Fabrics Co.

Avtex Fibers Inc.
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Monsanto Textiles Co.
North American Rayon Corp.
Phillips Fibers Co.

interest. The Bureau is better equipped than the private sector to use all sources of information and review to insure the reliability of research programs and test methods addressing the fire phenomenon.

We hope that your Subcommittee will reinstate funding for 1984 for the Center for Fire Research. If you have additional questions concerning this subject, please let me know.

Sincerely yours,

Charlie

CWJ/ls

WOOD
HEATING
ALLIANCE

1101 CONNECTICUT AVENUE, N.W. SUITE 700, WASHINGTON, D.C. 20036—202/857-1181

February 17, 1983

Hon. Doug Walgren, Chairman
Subcommittee Science Research & Technology
Committee on Science & Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Walgren:

The Wood Heating Alliance urges you to restore the budget of the Center for Fire Research in the National Bureau of Standards.

The Wood Heating Alliance is the national trade association of woodstove manufacturers and dealers. We feel strongly that the entire country has benefited greatly from the basic research being conducted by the Center for Fire Research (CFR).

The CFR has been conducting important research into the formation of creosote from solid fuel appliances and into safe techniques for venting solid fuel appliances through combustible walls. The Consumer Product Safety Commission has identified these issues as the chief causes of home fires related to solid fuel appliances. The CFR research is vital to our efforts to improve public safety in the use of these devices.

The woodstove industry is a small and fragmented industry. Hundreds of small manufacturers produce the appliances and none of them have the resources to conduct the needed research in these vital safety areas.

The CFR has done a fine job communicating the results of its research to our industry. We expect that our industry will make full use of the CFR research in the new product designs and safety measures.

We hope your Subcommittee will restore the funds in the FY 1984 budget for the CFR research.

Sincerely,

Carter Keithley
Executive Director

CK/d

FORMERLY FIREPLACE INSTITUTE AND WOOD ENERGY INSTITUTE

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING

BERKELEY, CALIFORNIA 94720

March 2, 1983

P. Pagni
UNIVERSITY OF CALIFORNIA
MECHANICAL ENGINEERING
BERKELEY, CALIFORNIA 94720
TM01

Honorable Doug Walgreen
Member of House of Representatives
Washington, D.C. 20515

Dear Congressman Walgreen:

May I ask for your assistance in saving many lives, avoiding uncountable heinous injurys, and preventing future disasters?

It is inconceivable to me that the United States, whose national fire loss record is already one of the worst in the world (recent catastropic fires at the MGM Grand Hotel, the Stouffer Inn, and the Westchase Hilton Hotel do little to ameliorate this record), would choose to become the only major civilized nation without a national fire center. And yet the current budget proposal does precisely that - it terminates the Center for Fire Research at the National Bureau of Standards within the Department of Commerce.

This Center is the worldwide leader in fundamental fire research with an excellence level truely unusual in government or university research centers. The Center provides a focus for fire related research and application activity throughout the United States and indeed the world. Without this focus, our life and property losses to fire would assuredly climb exponentially. There will also be serious consequences to national and civil defense (the burning of the Sheffield and other ships at the Falkland Islands dramatically emohasize the need for further fire research).

This is a technical question. Please note my professional opinion that proper fire safety assessment is at the very forefront of combustion research. Manufacturers do not have and cannot afford to obtain the competence required to replace this Center.

I too am concerned about high government budget deficits. But this is false economy. The "saving" of the Center's yearly budget of 6 million dollars will not bear the scrutiny of cost-benefit analysis.

Please vote to restore the Center for Fire Research to last year's level of support in this year's budget. I thank you and our children and grand children will thank you.

Sincerely,

Patrick J. Pagni
Professor

PJP:jar

Society of
Fire Protection Engineers

Advancing the Art and Science of Fire Protection Engineering

60 Batterymarch Street
Boston, Massachusetts 02110
617 482-0686

February 28, 1983

The Honorable Douglas Walgren
Chairman, Subcommittee on Science, Research
& Technology
Committee on Science and Technology
U.S. House of Representatives
Washington, DC 20510

Dear Sir:

The Society of Fire Protection Engineers is deeply concerned for the future of the Center for Fire Research of the National Bureau of Standards. Its demise would seriously curtail advances being made by the CFR in the science and technology of fire.

Enclosed is a statement which reflects our opposition to the current proposal to eliminate the CFR. Please enter it as an official part of the record of your oversight hearings.

Sincerely,

Maurice R. Boulais

M. R. Boulais, P.E.
President

cc: Dr. John Holmfeld
Carrye Brown

encl.

Society of
Fire Protection Engineers

Advancing the Art and Science of Fire Protection Engineering

60 Batterymarch Street
Boston, Massachusetts 02110
617 482-0686

February 28, 1983

Statement To:

Subcommittee on Science, Research, & Technology
Committee on Science and Technology
U.S. House of Representatives

In Opposition to the Elimination of the NBS Center for Fire Research

The Society of Fire Protection Engineers (SFPE) is the international technical Society for engineers involved in the multifaceted field of fire protection engineering. Its 3350 members, located primarily in the United States, include engineers in private practice, in industry (automotive, utility, ferrous and non-ferrous metal, petrochemical, petroleum, retailing, etc.), in government (local, regional, and national), in manufacturing and installation of fire protection equipment, as well as technical members of the casualty insurance industry.

The SFPE long range plan includes significant ties to fire research. This fact causes the SFPE deep concern for the potential elimination of the Center for Fire Research (CFR).

The statement of purpose for SFPE is: "to advance the application of engineering principles to protect man and his environment from fire." Two goals of the long range plan based upon that purpose are particularly germane . . . goal 1: "Professional Practice - to advocate the development and application of engineering principles with integrity, objectivity, and technical quality"; and goal 2: "Education - to transfer modern theory, principles, and practice to current and prospective fire protection engineers, allied professionals, and others."

The output of the CFR is in great measure not only used by the fire protection engineer in his daily practice but is a primary factor in the technical advancement of the profession which is to protect life and property from unwanted fire. Three examples will illustrate.

In 1975, a five year program was initiated at the CFR to develop a quantitative evaluation system for grading the fire safety of health care facilities. Users of the system can determine combinations of widely accepted fire safety equipment and building construction features which provide a level of fire safety equivalent to that required by the widely accepted "Life Safety Code" of the National Fire Protection Association (NFPA). The system provides flexibility to both the designer of new facilities and to the renovator of existing health care facilities. Equivalency is judged to exist when the total input of the occupancy risk factors and the compensating building fire safety features produce a level of fire safety equal to or greater than that achieved by rigid conformance to the explicit requirements of the NFPA "Life Safety Code." In this evaluation, fire safety performance is guaged both in terms of overall fire safety impact and in the depth of redundance.

This system is in place today and fire protection engineers are using it to evaluate innovative engineering approaches to fire safety in health care facilities, such as those of the Veterans Administration. This effort is continuing and in current development are evaluation systems for apartment buildings, board and care homes, homes for the elderly, prisons and jails, seasonal hotels, and in the future coal mines.

Without the CFR, this pioneer system would not have been developed or would have been delayed. The cost savings resulting from this evaluation technique would not have been realized.

CFR, in a second project important to the fire protection engineer, is developing means to predict the actual burning hazard of furnishings used in a building such as upholstered furniture, desks, tables, chairs, filing cabinets, etc. Hazard is expressed in rate of energy release, smoke development rate, and toxic gas production. This will enable the engineer to predict the total amount of energy and other products of fire likely to be produced within a given room or group of rooms. With this, the engineer can evaluate the total impact of fire on the building occupants and on the structure. Then, rather than arbitrarily condemning a particular furnishing because of its hazard potential, alternative fire safety features can be designed and the total hazard managed.

This breakthrough can be further applied to places of public assembly such as theaters, sports arenas, and schools thus enabling the fire protection to be engineered on the basis of the potential output of an unfriendly fire in the particular structure.

An effort such as this, in all probability, could not have been undertaken by the private sector because it involves such a myriad of industries and special interests . . . man made fabrics, natural fabrics, wood, plastics, steel, aluminum . . . none of which would independently have sufficient incentive to undertake the research.

CFR in another project is applying theories of thermodynamics and fluid mechanics to fire. This effort is providing engineering calculations that can measure or predict fire development without actually having a fire. In the past, it has been necessary to conduct expensive and sometimes inconclusive large and small scale fire tests, to observe working fires or to rely on post fire investigations.

Fire protection engineers need such substantiated theory now in development at the CFR. With the theory discussed above, the engineer could predict the migration of smoke and toxic gases. Given such a prediction, a system could be designed which would assure that occupants of any particular structure could make a timely escape from any potential fire. This work like the previous examples is uniquely peculiar to the mission of the CFR and would not likely be undertaken in the private sector because it is not oriented to a single industry.

Engineering is the application of scientific principles to practical ends such as the design, construction, and operation of efficient and economical structures, equipment, and systems. Fire protection engineers need the CFR so that they may continue to apply "scientific principles" in a manner which produces "practical ends." Those practical ends are the protection of life and property from fire. And according to the NFPA, fire cost America 6,700 civilian deaths and in excess of $6 billion in property damage in 1981. Mainenance of the CFR at $5.89 million or .01 percent of the $6 billion annual loss is appropriate.

**The Society of the
Plastics Industry, Inc.**

SPI

605 14th Street, N.W.
7th Floor
Washington, D.C. 20005
(202) 628-0270

March 22, 1983

Honorable Doug Walgren
Chairman, Subcommittee on Science, Research and Technology
House Committee on Science and Technology
U.S. House of Representatives
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Representative Walgren:

The Society of the Plastics Industry is concerned about the deletion of funds for the National Bureau of Standards' Center for Fire Research in the agency's recently proposed budget for Fiscal Year 1984. The pioneering work the Center has performed in the area of fire technology in recent years has provided a sound basis for a better understanding of the hazards associated with combustion. This kind of research is essential to the continuing effort to reduce fire deaths in this country.

The plastics industry has been a long-standing active supporter of the programs conducted by the NBS Center for Fire Research. Although considerable fire technology research is conducted by industry and independent institutions, the Center possesses a research capacity that cannot be readily duplicated elsewhere. Its elimination would severely handicap efforts to improve fire safety in this country.

We urge the House Subcommittee on Science, Research and Technology to restore FY 84 funds to the NBS Center for Fire Research at a level that permits this invaluable work to continue.

Sincerely,

Lewis R. Freeman
Director
Federal Government Affairs

LRF/clw

cc: House Subcommittee on Science, Research and Technology members

APPENDIX V—Statements and Letters U.S. Fire Administration

STATEMENT
BY
CONGRESSMAN BERYL ANTHONY, JR.

TO THE
SUBCOMMITTEE ON SCIENCE, RESEARCH & TECHNOLOGY

HEARING ON FEDERAL FIRE
PREVENTION & CONTROL ACT

MARCH 16, 1983

I AM PLEASED TO HAVE AN OPPORTUNITY TO SHARE WITH THE MEMBERS OF THE SUBCOMMITTEE, A PROGRESS REPORT ON OPERATION DIXIELAND.

WHEN MOST PEOPLE THINK OF FIRE PROTECTION THEY THINK OF A RED TRUCK, LIGHTS FLASHING, A SIREN SHRIEKING, RUSHING TO A BLAZING BUILDING.

FIRE ENGINES ARE A COLORFUL AND IMPORTANT PART OF FIRE PROTECTION, BUT THERE IS MORE TO FIRE PROTECTION THAN EQUIPMENT AND PUTTING OUT FIRES. A REALLY EFFECTIVE FIRE PROTECTION SYSTEM IS ONE IN WHICH PEOPLE AND EQUIPMENT WORK TOGETHER TO PREVENT FIRES.

THE UNITED STATES' FIRE DEATH RATE EXCEEDS THAT OF ALL OTHER INDUSTRIALIZED NATIONS. OF THE 10 STATES WITH THE WORST FIRE DEATH RATES, NINE ARE SOUTHEASTERN, INCLUDING MY OWN STATE OF ARKANSAS. AN ESTIMATED 100 TO 120 PERSONS ARE KILLED EACH YEAR BY FIRE IN ARKANSAS AND ANOTHER 500 PERSONS ARE INJURED ANNUALLY IN FIRES.

THE RATE OF DEATH DUE TO FIRE IS HIGHER FOR PEOPLE WHO LIVE IN RURAL AREAS, THOSE WHOSE INCOMES ARE BELOW THE POVERTY LEVEL, AND BLACKS.

SINCE COMING TO CONGRESS I HAVE BEEN ADVOCATING THAT STATES DEVELOP MASTER PLANS FOR FIRE PROTECTION. MASTER PLANNING PROVIDES AN ORGANIZED APPROACH TO DEFINING, OBTAINING, AND MAINTAINING THE LEVEL OF FIRE SAFETY AND THE CONSEQUENT FIRE PREVENTION AND CONTROL SYSTEM DESIRED BY A COMMUNITY. CITIZEN AWARENESS AND PARTICIPATION IN FIRE PROTECTION IS THE KEY TO THE SUCCESS OF MASTER PLANNING.

I have worked closely with the Federal Emergency Management Agency's U.S. Fire Administration to develop a unique and comprehensive approach to fire safety in Arkansas called Operation Dixieland. It is a combined effort by federal, state, and local officials. The U.S. Fire Administration is working closely with the Arkansas Fire Academy at Camden, the state focus for the project, and with other state agencies, local communities, and the private sector.

Under Operation Dixieland, a multi-program approach to fire safety--ranging from a Sesame Street Fire Safety Program aimed at pre-school children, to the training of fire personnel at the National Fire Academy, to research into and testing of new designs in protective fire fighter clothing, to the training of citizens to detect fire hazards in their homes and communities--has been developed.

With initial funding of $80,000 from the U.S. Fire Administration, Operation Dixieland began in October, 1980. Although the project received federal funding only through September, 1982, the programs of Operation Dixieland have continued. Specific accomplishments of this unique program include:

--National Fire Academy Campus Courses. Through Operation Dixieland, 51 students have been sent to the National Fire Academy in Maryland for special training. This has increased the level of preparedness of the Arkansas Fire service. These people have in turn shared their training with other Arkansas fire departments.

-- Public Fire Education Programs. A special program on public education has been established at the Morris Booker Memorial College in Dermott, Arkansas. The persons trained through this program are now working throughout the State in public fire education programs. In addition, public service announcements and programs on smoke detectors, kerosene heaters, woodburning stoves and other relevant topics continue to be used in the state. A statewide Public Education Resource Catalog has been developed and is in use by local fire departments. The catalog details the resources available for public education activities, as well as those available for training purposes. Four Fire Service Resource Centers have also been established in the state. These centers stock basic information and visual aid equipment which local fire departments can use in conducting their in-house or public education seminars.

-- Residential Fire Safety Surveys. Hundreds of homes have been surveyed in Arkansas by volunteers who are trained to detect hazardous conditions and counsel the homeowner on how to correct problems. The survey has collected valuable information on local fire problems which assists local fire departments in their fire protection planning. Efforts have been directed toward reaching those segments of the population which are experiencing a high incidence of fire deaths and injury.

-- FIRE INCIDENCE REPORTING SYSTEM. THIS SYSTEM IS ALLOWING THE ARKANSAS FIRE SERVICE TO MOVE INTO THE FIELD OF DETAILED FIRE INCIDENCE REPORTING. WE DO NOT YET UNDERSTAND AS MUCH AS WE SHOULD ABOUT OUR FIRE PROBLEM, BUT WITH PROPER USE OF THIS DATA, THE FIRE SERVICE CAN MORE EFFECTIVELY AND EFFICIENTLY ADDRESS THE PROBLEM.

-- SESAME STREET PRE-SCHOOL FIRE SAFETY. THIS IS AN EXCELLENT EXAMPLE OF THE PUBLIC EDUCATION EFFORTS IN THE STATE. SHORT TERM BENEFITS OF THE PROJECT WERE DIRECTED AT REDUCING THE FIRE DEATH AND INJURY RATES OF PRE-SCHOOL CHILDREN. THE PROGRAM ALSO INCREASED THE FIRE DANGER AWARENESS OF THESE CHILDREN, THUS PROVIDING FIRE SAFETY BEHAVIOR PATTERNS THAT WILL BE RETAINED. FIVE THOUSAND PRE-SCHOOL CHILDREN IN FOUR ARKANSAS CITIES HAVE BEEN TRAINED IN BURN PREVENTION, FIRE DANGER AWARENESS, AND "STOP, DROP AND ROLL" TECHNIQUES THROUGH THIS PROGRAM.

-- PROJECT FIRES PROTECTIVE CLOTHING. A COOPERATIVE RESEARCH PROJECT WITH FEMA'S NATIONAL FIRE DATA CENTER HAS BEEN CONDUCTED IN AN EFFORT TO TEST NEW DESIGNS IN PROTECTIVE FIRE FIGHTER CLOTHING.

THIS IS, BY NO MEANS, A COMPLETE ACCOUNT OF THE PROJECTS OR PROGRESS MADE THROUGH OPERATION DIXIELAND. IN ARKANSAS WE ARE HOPEFUL THAT OPERATION DIXIELAND WILL BECOME THE MODEL FOR THE SOUTHEASTERN STATES AND THE ENTIRE COUNTRY. WE HAVE ALREADY LEARNED THAT THE PROGRAM WILL HAVE TO BE MODIFIED AND ADAPTED TO THE UNIQUE NEEDS OF EACH STATE AND REGION. WE FOUND IN ARKANSAS THAT THE FIRE PROBLEMS ARE AS VARIED AS THE STATE ITSELF. NO ONE PROGRAM OR APPROACH WAS APPLICABLE STATEWIDE.

THE KEY INGREDIENTS FOR OUR SUCCESS HAS BEEN COOPERATION BETWEEN STATE, LOCAL, AND FEDERAL OFFICIALS; THE DEVELOPMENT OF A COMPREHENSIVE MASTER PLAN FOR FIRE SAFETY; AND CITIZEN AWARENESS AND PARTICIPATION IN FIRE PROTECTION.

I BELIEVE THE FUNDS WE RECEIVED UNDER THE AUTHORITY OF FEDERAL FIRE PREVENTION CONTROL ACT HAVE RESULTED IN BETTER FIRE SAFETY FOR THE PEOPLE OF MY STATE. I URGE YOU TO TAKE THE SUCCESS OF THIS PROJECT INTO CONSIDERATION AS YOU REVIEW THIS LEGISLATION.

Bill Gunter
STATE TREASURER
STATE FIRE MARSHAL
INSURANCE COMMISSIONER

Office of
State Fire Marshal
Larson Building
STATE OF FLORIDA
TALLAHASSEE 32304

March 2, 1983

Congressman Don Fuqua
Committee on Science and Technology
2321 Rayburn, H.O.B.
Washington, D.C. 20515

Dear Congressman Fuqua:

It has come to my attention that the Committee on Science and Technology will start hearings on the National Fire Incident Reporting System, March 16, 1983. As President of the National Fire Information Council and NFIRS Program Manager for the State of Florida, I wanted to acquaint you with some of the important information we have learned from the NFIRS program in Florida.

(1) Of the 266 people who died as a result of fire in 1981 only 6 had smoke detectors in their homes.

(2) While 13.8 percent of Florida's population is Black, 30.1 percent of all Florida's fire death victims were Black.

(3) While 24.3 percent of Florida's citizens live in homes with a value of $30,000 or less, 44.3 percent of Florida's fire death victims died in homes with a value of $30,000 or less.

(4) Grease fire in the kitchen are the leading cause of residential fire in Florida.

(5) Alcohol, drugs, and cigarettes were contributing factors in over 25 percent of the fire deaths reported.

(6) 46.6 percent of fire death fatalities occurred between 10:00 p.m. and 6:00 a.m. - the usual sleeping period. A time when smoke detectors could have saved lives.

(7) 43 percent of Florida's fire death victims were under 10 or over 65 years of age.

The important aspect of all these grim facts is that the public can be educated as to how these fire deaths could have been prevented. Public education, working with facts from

Congressman Don Fuqua
Committee on Science and Technology
2321 Rayburn, H.O.B.
Washington, D.C. 20515

Page 2

NFIRS is the answer to the fire problem in Florida as well as the entire United States.

In Florida, State Fire Marshal Bill Gunter, has taken the data from NFIRS and used it to pinpoint problem counties in our state. He has appointed a Special Task Force to go into these problem counties and work with the populace through meetings in churches, schools, and with civic groups.

This Task Force has had tremendous success with over 14,000 students, teachers, and citizens attending meetings on fire safety. Another important fact about these meetings is that they deal with actual facts for these citizens' hometown, not statewide or nationwide, but hometown. This enables the public education instructor to really bring the grim reality of fire home.

If you do not know what your problems are, how can you solve them? NFIRS provides facts to solve problems. I strongly encourage the continued support of the NFIRS Program by the Committee on Science and Technology and respectfully request that this letter be entered into the official record of the NFIRS hearings.

Thank you for your time and consideration.

Regards,

E.W Stewart

E. W. Stewart, Program Manager
Florida Fire Incident Reporting System

EWS:bt

MAR 18 19

CITY OF PHILADELPHIA
FIRE DEPARTMENT
3RD & SPRING GARDEN STREETS, PHILADELPHIA, PA. 19123

JOSEPH R. RIZZO
COMMISSIONER

March 14, 1983

The Honorable
Doug Walgren
Chairman
Subcommittee on Science,
  Research & Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Congressman Walgren:

I would very much have liked to testify regarding the Fiscal Year 1984 Budget Proposal for Federal Fire Prevention and Control programs, but another commitment makes this impossible.

I would like to go on record as a firm supporter of the United States Fire Administration, the National Fire Academy, and the need for adequate funding of these agencies.

After 26 years of employment with the Philadelphia Fire Department and seeing the great strides that have been made in recent years regarding fire prevention and fire protection, I can assure you and the members of your committee that only through increased focus on the national fire problem can this trend continue.

If I can ever be of service, please do not hesitate to ask.

Sincerely,

J. Walsh

Harry J. Walsh
Deputy Chief
FIRE PREVENTION DIVISION

HJW:kvw

MAR 2[illegible] 1983

OFFICE OF THE

Westmoreland County Commissioners

101 Courthouse Square
Greensburg, Pennsylvania 15601
412/834-2191

TED SIMON
CHAIRMAN

JOHN W. REGOLI
VICE CHAIRMAN

ROBERT H. MILLER
SECRETARY

March 15th, 1983

The Honorable Doug Walgren (D-PA)
Subcommittee on Science, Research, and Technology
House Committee on Science and Technology
2321 RayBurn Building
House of Representatives
Washington, D.C. 20515

Dear Congressman Walgren:

We are urging your support towards continuation of the budgeted programs designed to develop scientific data to reduce fire deaths and injuries in this nation.

Our position is more rigid labeling of materials standards must be developed as a by-product of research, concerning the manufacturing of synthetic building products for residential use. Today's firefighter is subjecting his body to more toxic smoke and gases than ever before in the history of this country. Yet, only limited information is available on the toxicity of building materials used in today's construction industry. An example would be certain type of insulation used in residential construction subjected to heat and flame produces cyanide and/or formaldehyde gases. Should a firefighter's self-contained breathing apparatus develop leakage or become inoperable, or his personal gear get torn, severe injury and possibly death may occur as the result of his body being subjected to toxic vapors. Required "toxicity of material" labels on building materials which have been tested through research would be a good start. In summary of this first part, "toxicity" is defined as the ability of a material to cause bodily harm by chemical action. The scientific data of the manufacturer is already there. Now it is up to the federal government to make sure the data available can be directed to the fire fighter via legislation requiring same.

The second part of our appeal is to urge your consideration and support to keep funding programs of the United States Fire Administration directed at fire prevention through "public education." It is our understanding the "Public Education Division" of U.S.F.A. has been all but obliterated from the present administration. We cannot comprehend how a program as vital as this could fall by the wayside. In our County of nearly 400,000 people we have shown incredible results due to public education. Many of our local fire prevention/public education programs are a direct result of in-put assistance received from the Public Education Division of U.S.F.A. Fire deaths alone in 1981 in Westmoreland County stood at 13, in 1982 they dropped to 4 in that 12-month period. Our programs have been running hard since 1980. Seminars, conferences, institutes, etc. sponsored on a regional basis to indoctrinate local fire officials and organizations of the types and kinds of fire prevention/public education programs available from the U.S.F.A. is the answer. This answer will require funding! And let me make it perfectly clear, we in the active fire service today are going to pay our "fair share" for training and education. We do not expect any of this for nothing. If the Feds and U.S.F.A. make the programs available we will do our part.

There are many other areas we would like to address: residential sprinkler protection...mandatory smoke detection and alarm systems for all single family dwellings...fire safety in modular constructed mobile homes, etc., but time in this testimony does not permit us to do so.

We thank you for the opportunity to supply you with this information. We stand ready to serve you with additional data at your request backing up our presentation.

Kindest regards,

Jack W. Simon

Jack W. Simon
Director of Administration
County Liaison
Westmoreland County Firemen's
Association

JWS/eo

STATEMENT OF THE
TOBACCO INSTITUTE
ON FEDERAL EMERGENCY MANAGEMENT
ADMINISTRATION AUTHORIZATION
HOUSE SUBCOMMITTEE
ON SCIENCE, RESEARCH
& TECHNOLOGY
OF THE
COMMITTEE ON
SCIENCE & TECHNOLOGY

MARCH 16, 1983

The Tobacco Institute, a trade association of tobacco manufacturers, appreciates this opportunity to express our support for reauthorization of the United States Fire Administration ("USFA").

The Tobacco Institute and its member companies believe that a reduction in the number and severity of accidental fires in this country can best be achieved by a broadbased cooperative effort involving private industry, fire service organizations, and local, state and federal governments. None of these sectors can accomplish the task on its own. But each sector, including the USFA, can provide a unique contribution to the goal of fire prevention and control.

One of the most important functions of the federal government in this area -- a task that in our view cannot be performed adequately by any other sector -- is the nationwide collection and analysis of data concerning accidental fires, accomplished by the USFA through the National Fire Incident Reporting System("NFIRS"). This system provides the basis for a rational allocation of money and resources by government and private sectors to those areas of fire prevention and control where they are most needed. For example, NFIRS data show that during the five-year period 1977-1981 heating-related fires in one- and two-family dwellings, where three quarters of the nation lives, increased 39 percent. Residential fires caused by arson also increased (up 11 percent), while cooking fires decreased by 10 percent, electrical fires decreased by 21 percent, and smoking-related fires dropped most sharply (by 23 percent). These data provide useful guide posts in addressing the fire problems in this country.

With the USFA and other fire prevention agencies of the federal government providing overall analysis and coordination, private and local government initiatives can be undertaken most productively. As one industry whose products sometimes are involved in accidental fires, the tobacco industry is actively engaged in such initiatives. We would like to describe certain of the activities being undertaken by The Tobacco Institute, on behalf of our member companies, to give you an idea of the kind of industry efforts that can serve as part of a total program for fire prevention and control.

Because the accidental fire picture in Europe is so much better than in the United States, we asked Mr. Philip S. Schaenman, President of TriData Corporation and former Associate Administrator of the USFA, to investigate reasons for the differences. Our hope was that Mr. Schaenman's investigation would uncover fire prevention practices being utilized successfully in Europe that could be adapted and used in this country. What Mr. Schaenman found was that European countries, such as Switzerland, have focused on a broad range of measures -- fire prevention education, code enforcement, inspection programs and insurance incentives -- that address the complexity of the accidental fire problem.

Drawing on the lessons that we learned from Mr. Schaenman's work, The Tobacco Institute -- with the full support and cooperation of the cigarette manufacturing companies -- has initiated an attack on the accidental fire problem, and particularly that subset of the problem thought to involve carelessly handled or dropped cigarettes. That attack has proceeded on two parallel fronts. This is in addition to the individual tobacco company research and other work that is continuing in the fire prevention area.

First, as I noted earlier, we have witnessed in this country over the past five years more than a twenty percent decline in the number of accidental fires attributed to cigarettes. In an effort to accelerate that reduction, we have been working with other industries as well as members of the firefighting community. For example, we have supported through grants and in other ways the continuing efforts of the Upholstered Furniture Action Council ("UFAC") to reduce the flammability of upholstered furniture.

As early as the beginning of this past year, the UFAC standards already had produced promising results. Guilford Laboratories has conducted, at the request of The Tobacco Institute, tests on upholstered furniture that complies with the UFAC standards -- furniture employing fabrics and construction methods being used in more than 50 percent of the new furniture being sold in this country. None of the furniture pieces in the Guilford tests ignited when cigarettes, representative of the United States cigarette market, were placed on them.

Of even greater potential significance have been our cooperative efforts with UFAC to develop and evaluate substances that could be applied directly to furniture fabric so as to decrease its vulnerability to ignition from an open flame or smoldering ignition source, including cigarettes. Although those efforts have been difficult and time-consuming, and considerable additional testing is needed, there may soon be available to manufacturers and the public products that will solve the open-flame and smoldering ignition problem presented by a range of household furnishings -- including mattresses, carpeting and draperies, as well as upholstered furniture. An exciting aspect of these products is that they may be usable for in-home application on existing furniture and other household furnishings.

Our second area of concentration at The Tobacco Institute has involved the firefighting community directly. One of the primary lessons that we learned from Mr. Schaenman's study is that many European countries are doing a far better job of fire prevention and fire prevention education than we are doing in the United States. Our discussions with fire-prevention specialists also convinced us of the importance of smoke detectors and other fire alarm systems in reducing the number and severity of accidental fires.

Taking advantage of Mr. Schaenman's study and counsel, we have designed and implemented a pilot program that is helping the fire departments of nine major cities in this country do a better and more thorough job of educating the public about fire safety. After working with fire department personnel in these cities to identify fire prevention education needs, we have provided needed materials and supplies. We plan to monitor the use that is made of those materials and supplies, assess the extent to which they have enhanced the pilot cities' fire prevention efforts, and then make the results of that assessment available for the benefit of other cities and departments.

We also have helped to fund the development of a high school fire safety curriculum that has been tested successfully in the State of New York. Our understanding is that this curriculum and related materials will be made available nationally through the National Fire Protection Association ("NFPA") as an adjunct to NFPA's excellent Learn-Not-To-Burn Program, which previously had focused on the elementary school level.

In addition, we have been working with the National Volunteer Fire Council. The great majority of American communities are protected by volunteer firefighters. Public response to their fundraising and recruiting needs is crucial. To help in these areas, The Institute is preparing a complete array of creative materials for use in all media.

This initiative is designed to help volunteer departments attract committed volunteer personnel and raise funds to defray the cost of local firefighting and fire prevention efforts.

Finally, despite the great strides that have been made in the last few years, one-third of all American homes still are not equipped with smoke detectors or other fire alarm systems -- and those important and effective devices too often are not properly located or maintained. To help solve these problems, we have been working with the NFPA on the design of model smoke detector programs that can be implemented successfully on the local level. We currently are evaluating proposals from NFPA in this area and expect to be moving forward with NFPA in the coming months.

The tobacco industry is proud of and committed to the programs that I have described. We are convinced that private initiatives such as these by our and other industries can help lead to the solutions we all seek to the problem of accidental fires. But we also are convinced that the U.S. Fire Administration must continue to play an active role to encourage coordinate and analyze the results of such private as well as state and local government initiatives. For that reason, The Tobacco Institute and its member companies support reauthorization of the United States Fire Administration.

As has been stated by Mr. Schaenman, "the fire problem is multidimensional and requires several apprcaches, including:

development of public awareness and education programs on safety practices, on a nationwide scale; increased use and maintenance of smoke detectors and other fire safety devices; strengthened building fire codes and rigorous enforcement by those responsible; improved training and protective equipment for firefighters; and continued refinement of fire statistics so that the overall problem of fire prevention can be better understood and addressed.

"The problem of fires in the United States requires such a comprehensive approach. Europe has already reached the level of safety we set as our goal to reach in a generation, and they have done it without doing anything exotic. We could do the same, and not have to wait several years for new programs to be developed. The necessary legislative mandate already exists in the charters of the U.S. Fire Administration and the National Bureau of Standards."

○